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THE CENTRAL LIGHTING STATION OF THE SOCIETE GRAMME AT THE PARIS EXHIBITION.

THIS central lighting station is situated immediately outside of the Machinery Hall, on its northeastern side, and adjoining the central station of the Syndicate. To it is intrusted the entire lighting of the French and English systems of illuminated fountains, a large portion of the interior lighting of the grand dome, comprising the gallery and upper portion of the dome, by incandescent lamps of 500 candle power, and the lighting of the Machinery Hall by four immense electroliers suspended at 130 ft. above the ground level, and containing in all forty-eight Gramme arc lamps of a total luminous intensity of 450,000 candles.

The general arrangement of the mechanical and electrical machinery will be understood from the perspective view, Fig. 1, and plan of the station, Fig. 2. The whole of the electrical plant, including dynamos, switchboards, lamps, and measuring instruments, is supplied by the Societe Gramme, of Paris, who work the patents of M. Gramme. Of this company, M. Hippolyte Fontaine, the president of the International Syndicate of Electricians, is the administrator. We are indebted to *The Engineer* for our illustrations and the following particulars.

It will be remembered that M. Fontaine read a paper before the Societe Internationale des Electriciens some time before the opening of the exhibition on the lighting arrangements made by the Syndicate, which paper was translated verbatim in the English technical press at the time. The whole of the wiring, which by the nature of the installations was attended with some amount of risk and difficulty, was carried out by this company and brought to a successful termination some three weeks before the opening day, trial runs of the circuits taking place on the 16th and 17th of April by the aid of one of the engines and two dynamos.

The six dynamo machines furnishing the electrical power are of the latest type brought out by the Societe Gramme, and are erected as shown at one end of the building in pairs, each pair being driven by one engine. We shall deal with these machines in order, remarking on their most salient features and the scheme of distribution of power by each, from details kindly supplied to us by Mons. E. Javaux, the director of the company, and Mons. Moinet, the company's electrician at the exhibition. The entire motive power, including both boilers and engines, has been supplied by the English engineering firm, Messrs. Davey, Paxman & Co., of Colchester, whose name is widely known in England in connection with the supply of the motive power for the lighting of the Inventions, Health, Fisheries, and Colonial and Indian exhibitions in London, and in France in connection with the supply of motive power for the immense compressed air undertaking introduced in Paris by M. Victor Popp for the continuous supply of power to that city. The building in which the machinery is installed at the exhibition is of brickwork, spanned with light angle iron girders supporting a glass roof and inclosing a clear floor space of about 7,000 square feet. In this space the machinery is disposed in such a manner as to allow everywhere of the closest inspection, the line of boilers being well separated from the engines, and an ample space being afforded the public to pass all round the machinery. The arrangement will be sufficiently clear by reference to the ground plan of the station—Fig. 2—for which we are indebted to the director of the firm's Paris house, M. Chas. Bellens, who took an active part in its design. It will be seen that in all nine boilers are installed in the station. These are Messrs. Davey, Paxman & Co.'s well-known locomotive type steel boilers, and are arranged in two batteries, one of five for supplying steam to the engines in the station, and another of four for supplying steam to the American and part of the British section in the Machinery Hall. The two batteries together generate 27,000 lb. of steam per hour. The working pressure is at 120 lb., each boiler evaporating 3,000 lb. of steam per hour, with a heating surface of 711 square feet, and occupying a floor space of 88 square feet. Before en-

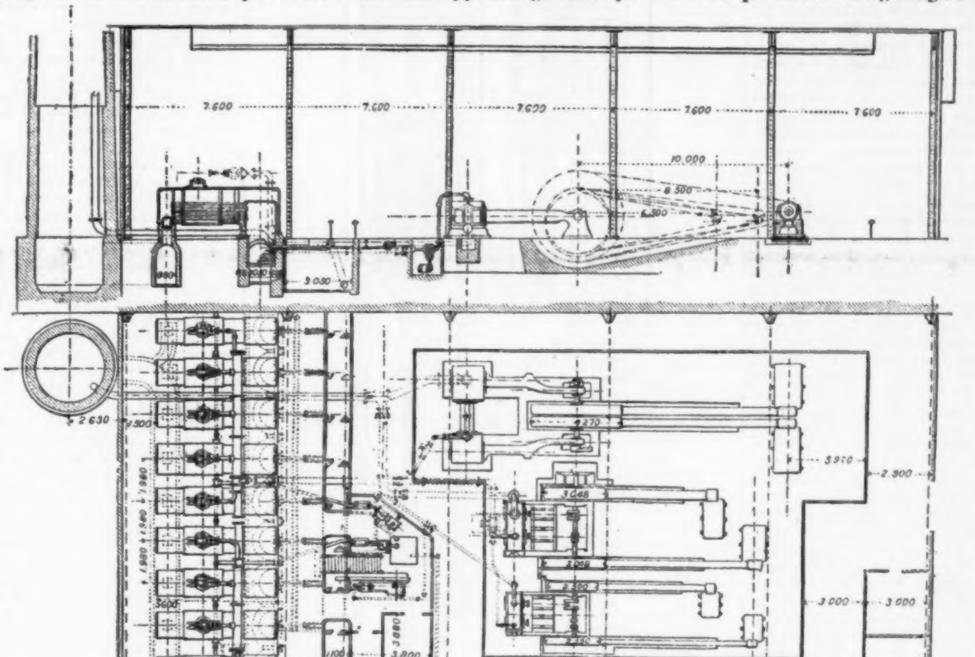


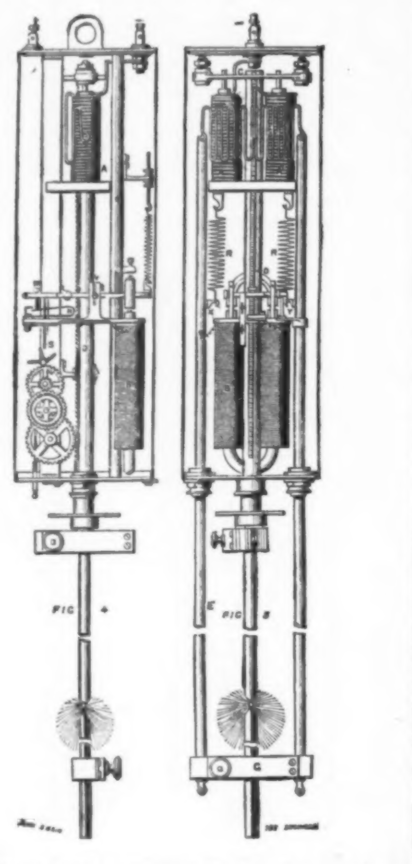
FIG. 2.—SECTIONAL ELEVATION AND PLAN OF STATION.

FIG. 1.—THE GRAMME CENTRAL ELECTRIC LIGHTING STATION AT THE PARIS EXHIBITION.

tering the main pipes the steam is led into a common receiver fixed above the boilers and extending along the whole series, a stop valve being provided for dividing off the steam from the two batteries of boilers, but which can be opened in case of accident to either set. Every precaution is taken to deliver dry steam to the engines by the fixing of steam traps and separators on the main steam pipes and drain cocks on the steam receivers, in addition to which the whole of the boilers, receivers, and steam pipes are well covered with an asbestos non-conducting composition by the United Asbestos Company, of London.

The system of mechanical stoking adopted for the boilers in this station has excited considerable attention and interest, and we therefore offer some particulars of its action, together with a sectional perspective view of the mechanism—Fig. 2 A. The system is due to M. Alexis Godillot, engineer, of Paris, who originally introduced it some five years ago for the utilization, as fuel, of what were generally considered the waste products of certain industrial processes. The system is now used largely on the Continent and abroad in saw and planing mills, tanneries, and in sugar, hemp, and flax factories where the furnaces are sustained by the residues resulting from the various manufactures, with a great economy in the cost of fuel. To accomplish the perfect combustion of these materials, which were in many cases impregnated with as much as 50 to 60 per cent. of water, M. Godillot constructed the step or fan shaped grate over which the fuel is fed and thoroughly dried before it is projected upon the fire bars. The system proved itself so handy and economical that some eighteen months back M. Godillot introduced it for the burning of inferior small coal, the drying process and automatic feed rendering it possible to fire with a coal of inferior quality containing a large percentage of moisture. In the exhibition there are two systems of water tube boilers fired on this system, viz., those of Messrs. Roser and Messrs. Dayde et Pille. The system consists in feeding the fuel along the interior of a horizontal iron trough by means of a rotating worm, the speed of which can be regulated as required. For the Paxman boilers, as shown in the sketch, there is one large main supply trough into which the coal is fed through a hopper at the back of the boilers on the floor level. The worm carries this along to the front of the boilers, where right and left handed worms feed it along on each side to the hoppers opposite the various furnaces. From each hopper the coal is then fed by separate troughs and worms to the delivery on the top of the step grate. The speed of feed in each of these delivery troughs can be adjusted separately by cone pulleys. Once the fuel is delivered on to the semicircular step grate, it is submitted to a drying and heating action as it slowly spreads out over the fan and falls from step to step, and before it has reached the fire bars combustion has begun. To prevent the burning of the step grate bars M. Godillot constructs underneath them a series of narrow water channels, also of iron, into which, without coming into contact with the coal, a small stream of water is fed. This drips through holes in each channel provided for its escape, and is finally drained off from below, effecting in its descent the prevention of too high a temperature of the step grate bars, and aiding the furnace draught. In the engraving the step grate and water channels are shown in section, and the build of the furnace and position of the fire bars are clearly indicated. It will be noticed that the ordinary fire bars of the boilers are dispensed with, and special brick furnaces built underneath the fire boxes, the draught being regulated by the flue registers and the large doors opening behind the step grate. A smaller door is also provided to give access to the furnace on each side. A single cylinder horizontal steam engine of four nominal horse power, provided with Paxman's automatic expansion gear, is employed to drive the Godillot system, and is supplied with steam through an equilibrium reducing valve from the main boilers. The feed water is pumped from a tank seen in the plan, which is supplied with water from the Seine. A vertical double-acting and a horizontal duplex pump, by Messrs. A. G. Mumford & Co., of Colchester, are employed respectively on each battery of boilers, the delivery passing through Schmid water meters constructed by MM. Espine, Achard & Co., of Paris. A Worthington pump is also used as a reserve. The power for running the dynamos is developed by three of Messrs. Davey, Paxman & Co.'s compound engines, fitted with Paxman's automatic expansion gear, and each of which drives by belting direct two Gramme dynamos.

We shall now deal with the three distinct engine and dynamo plants in order. The largest of these supplies the power for the lighting of both the French and English systems of fountains, and consists of two 175 horse power Gramme dynamos driven by a 360 indicated horse power coupled girder compound engine running at sixty-five revolutions. Two fly wheels, each of 14 ft. diameter and 19 in. face, are keyed side by side on the main shaft between the girders, and are connected by



belting direct to the pulleys of the two Gramme dynamos. The high pressure cylinder of this engine is 22 in. in diameter, and the low pressure 35 in., the stroke being 48 in. The piston speed at sixty-five revolutions is therefore 520 ft. per minute. High pressure steam can be admitted at will into either end of the low pressure cylinder, so that the engine may be started from any position. Both of the cylinders are bolted to massive cast iron pedestals held by the foundation bolts. Each girder forms in one casting the plummer block and crosshead guide bars, and is provided with a flange for bolting on to the cylinder.

The dynamos are each mounted upon three iron rails bolted to wooden sleepers, which are in their turn held by the foundation bolts in a direction parallel to the belts. The two outer rails are provided with screws gearing into the bed plate for shifting the dynamos and taking up the slack of the belts. The plummer block on the pulley side is cast with the bed plate, that on the other side being bolted on. The commutators are inside the bearings, and are each provided with eight brushes 1 in. wide. The bearings are lubricated by five oil wells on the pulley side and three on the other, the oil being fed over the shaft by rings rotating with it, and dipping into the wells. The two field magnet limbs are cast together with the yoke, the latter being bolted to the bed plate, and the pole pieces bolted on to the limbs from the inside.

These machines, which are seen to the right in the view of the station, and are numbered 1 and 2, are shunt wound, the shunt field circuits being brought to the switchboard, where the fields are controlled by an adjustable resistance and switch. The two machines are connected together in series, not for running on the three-wire system, since the circuits are brought direct to the outside terminals of the machines, but simply to divide the work equally between them. For the lighting of the fountains two circuits in parallel run from these combined dynamos, the fields being adjusted so that a potential of 240 volts is developed at the normal speed by the two machines together. Each circuit consists of an underground main and return conductor composed of three separate cables of a total sectional area of 0·21 square inch, the length laid down being 3,900 ft. for the main and return of each circuit. There are, therefore, twelve insulated cables between the station and the fountains. These cables are brought into the basement excavated beneath the fountains, where the two circuits are respectively connected to the arc lamps for illuminating the French and English fountains. For the former there are thirty lamps, sixteen of which are for the horizontal jets of the Coutan monumental fountain, and fourteen for the two rows of vertical jets. These are arranged three in series, and absorb 40 amperes each, the average total current being therefore 400 amperes.

For the illumination of Messrs Galloway's fountain there are eighteen lamps of 60 amperes arranged in the same manner, and therefore absorbing an average current of 360 amperes. Actually, the total current indicated for the two circuits is about 850 amperes, which gives a current density in the cables of about 2,000 amperes per square inch. With this density, the amount of potential absorbed by the cables throughout their entire length is about 60 volts, leaving 180 volts available for each set of three lamps at the fountains. The electrical output from the two machines when running the fountains is therefore 204,000 watts—equivalent to 273 horse power. The ratio of the electrical output to the mechanical driving power for these machines is given as 89·2 per cent., and therefore for this output some 306 horse power is required on the dynamo pulleys. The indicated horse power of the coupled girder engine is 360, which therefore allows 15 per cent. loss on all the moving parts between the cylinders and the dynamo pulleys. The maximum current developed by these machines is 900 amperes; the weight per machine, 10 tons 12 cwt.; height of machine, 5 ft. 8 in.; and floor space occupied by each, 32 square feet. The required potential is obtained with an exciting current of 30 amperes at a speed of 340 revolutions, the latter being equivalent to a peripheral speed of the outside armature turns of 2,850 ft per minute. These machines are called upon at stated times, fixed by the administration, to light the four large electroliers of arc lamps in the Machinery Hall, to which we have already alluded. Each electrolier is constructed with an iron star frame, from the arms of which depend twelve lamps. Each lamp absorbs 60 amperes, burns carbons 1 in. diameter, and is of over 9 000 candles luminous intensity. The electroliers are suspended at the great height of 130 ft., only 16 ft. from the highest part of the span, this having been determined by M. Fontaine for the proper diffusion of the light. The appearance of one of these electroliers and its manner of suspension is shown in Fig. 6. The suspension rope passes over a pulley at the highest point in the span, and is wound on the drum of a windlass bolted to the girders on the level of the upper gallery.

The lamps are connected three in series throughout, separate main and return wires being taken from each set of three lamps to the switchboard in the central station. There are, therefore, eight wires to each luster, or a total of sixteen main and sixteen return wires for the whole.

The wires to each electrolier, although insulated, are maintained separate from each other by passing through holes in wood blocks fixed at intervals throughout their length. The sixteen main wires are brought into the station direct to a large resistance frame, where suitable resistances are permanently interposed. The distances of the nearest lusters from the station are 600 ft. and 750 ft. respectively, while the two farthest away are at 1,120 ft. and 1,460 ft. distance.

The extra resistances, added to the circuits of the two former, are therefore approximately double those added to the latter for the same current at the same potential. Each cable has a section of 0·031 square inch, which, at 60 amperes, gives a density of close on 2,000 amperes per square inch, and therefore causes an absorption on the main and return cables to the farthest electrolier of 50 volts, and to the nearest of 20 volts.

At the other side of the resistance frame the sixteen circuits join on to the row of lead fuses at the top of the main switchboard—Fig. 7. These are contained in porcelain boxes and can be easily replaced if blown. The sixteen return cables are connected together and brought to the board, where they are in connection with the free negative terminal of the two dynamos, 1 and 2. The returns from three lamps on each luster are, however, fixed so that they can be connected to dynamos 1 and 2 or 5 and 6, at will.

This switchboard is fixed close to the two largest dynamos, the circuits leading from which are controlled from it. The view of the station does not take in this board, and therefore a separate sketch of it is given in Fig. 7.

In this it will be seen that each circuit of arc lamps has its own fuse, ampere meter, and switch, and that all the circuits are joined in multiple by one bar across the board. The wires marked P and N are the free terminals of the dynamos 1 and 2, an ammeter being connected permanently to the latter, which therefore indicates the total current passing to whatever circuit. The dynamo terminal, P, is connected directly to the arc lamp switches by the copper bar running across the board, and to the French and Galloway fountains by the switches, F and G.

The circuit to the French fountains passes through an ammeter and an ampere-hour meter fixed to the board.

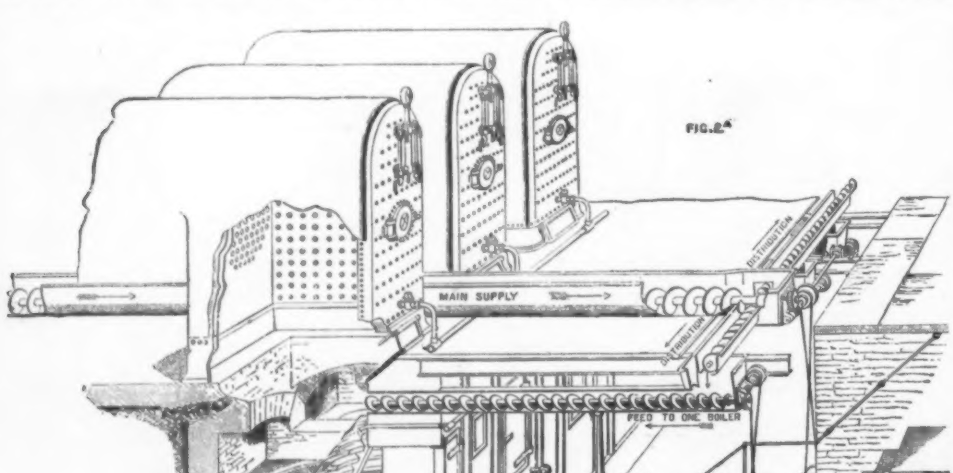
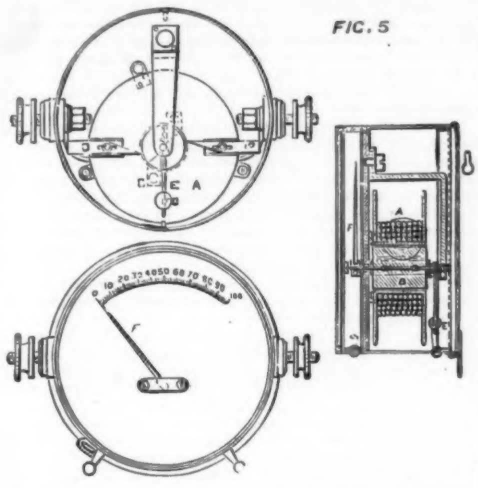


FIG. 2A.—MECHANICAL STOKING OF BOILERS.

This meter, which was construced by Messrs. Richard Freres, of Paris, is seen in elevation in the side view of the board (Fig. 8). On this part of the board is also mounted another set of switches, which are connected through resistances to some of the same arc lamp circuits mentioned above, the wires being connected direct to the ammeters. This is for the purpose of running a portion of the lamps on the lusters by the two dynamos, Nos. 5 and 6, when required, a return cable, R, leading from the board to these machines. The copper strap, C, connects these lamp returns to the



return, R, when they are run by the small dynamos, as shown in the figure, but is changed so as to connect them with the main return, N, when they are run from the large dynamos 1 and 2.

The fields of the dynamos Nos. 1 and 2 are connected through switches and resistances in the center of the board as shown, a voltmeter on the terminals of each machine being mounted on the board, and put into circuit by pressing the contacts, P P.

The ampere meters and voltmeters in use are the design of M. Javaux, and will be understood from the diagrams in Fig. 5, showing the construction of an ammeter.

The needle, B, of soft iron, turns with the spindle, to which is also attached an index pointer, F, with a counterpoise, E, the directive force on the system being that of gravity. Two pieces of soft iron, CC', fixed on the interior side of the coil, A, diametrically opposite to each other, become polarized under the action of the current in the same sense as the needle, and therefore repel it; while a second pair of soft iron pieces, DD', similarly placed, but exterior to the coil, become polarized in an opposite sense, and therefore attract the needle.

By this combination M. Javaux obtains porportionality between currents and indications; and since there is no permanent magnet about the instrument, the indications are constant for given currents, and permit the use of a direct-reading scale.

The engine and dynamos running in the center of the station are for the supply of light to the central dome. The engine is of the type known as the "Colchester" horizontal compound engine, with intermediate receiver. It is of 220 indicated horse power, and is fitted with Paxman's automatic expansion gear, the speed being 83 revolutions per minute. The engine is built on a massive cast iron girder frame of several parts bolted together, greatly facilitating transport and repairs. The low pressure cylinder can be supplied at either end with high pressure steam when required, so that the engine can be started in any position. The cranks are at right angles to each other, and the crank shaft, which is of mild steel, carries a counterbalance disk, a cast iron fly wheel, and a wrought iron pulley. The two latter, which are 10 ft. in diameter, drive the dynamo pulleys direct by belting, the dynamos being run at 440 revolutions per minute.

The dynamos are compound wound, and connected in series to a simple two-wire circuit. The cables, which are lead covered, run direct from the dynamos to the central dome, where seventy-two Sunbeam incandescent lamps of 500 candle power are installed in the interior. The lamps take 12·5 amperes and 100 volts, and there are thirty-six branches in parallel, each of two lamps, the total current on this circuit being, therefore, 450 amperes. In addition to this a circuit of nine arc lamps for lighting the station is

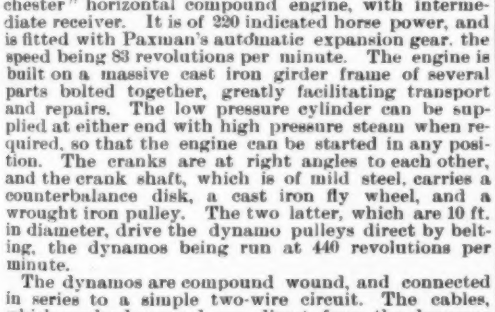
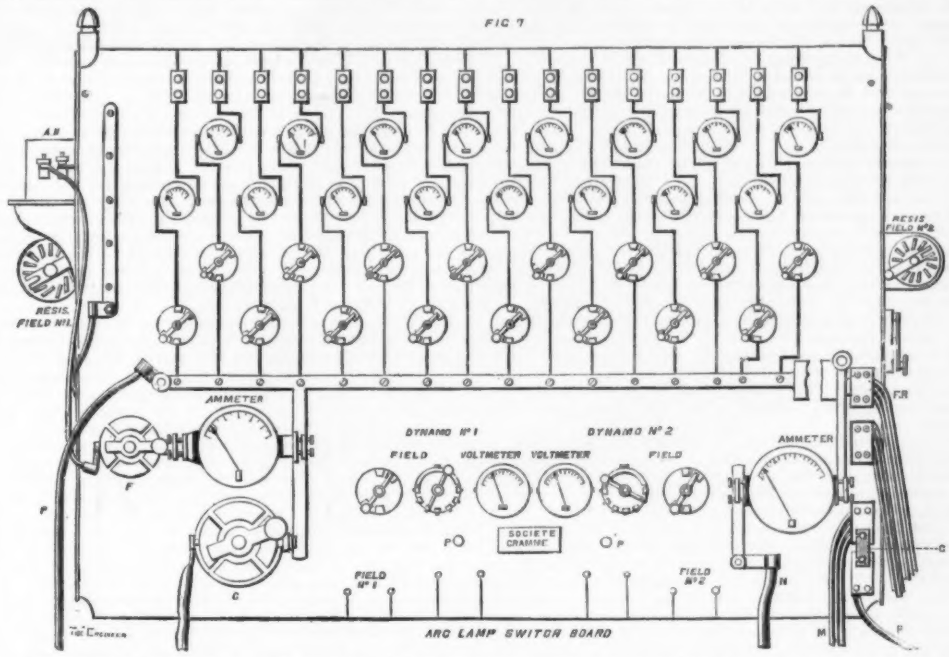


FIG. 6.

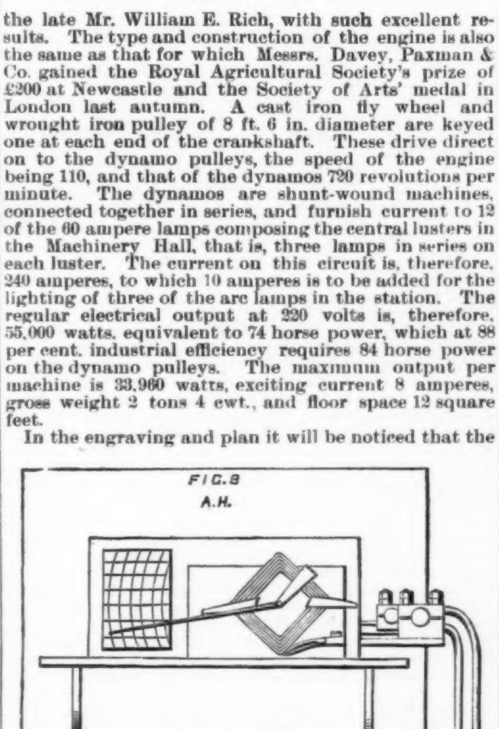
run from these machines, comprising six lamps of 10 and three of 15 amperes in branches of three in series. This raises the total current to 485 amperes, which at 220 volts gives a total output of 106,700 watts, or 143 horse power. The driving pulleys, therefore, require 162 horse power, with a given commercial efficiency of 88 per cent. The maximum output per machine is 58,200 watts, the exciting current in the shunt winding 5 amperes, gross weight 5 tons 3 cwt., and floor space 21 square feet. The construction of these dynamos is the same as those already referred to, with the exception that the field limbs are nearly cubical in shape, and the winding is compound.

The engine running dynamos 5 and 6 is of precisely the same type as the preceding, and indicates up to 120 horse power. The high pressure cylinder is 12¼ in. diameter, the low pressure 20 in., and the stroke 24 in. The engine is of exactly the same dimensions and type as that which, in October, 1886, was subjected to a trial at the Colonial exhibition in London, under ordinary running conditions, by Professor Kennedy and



the late Mr. William E. Rich, with such excellent results. The type and construction of the engine is also the same as that for which Messrs. Davey, Paxman & Co. gained the Royal Agricultural Society's prize of £200 at Newcastle and the Society of Arts' medal in London last autumn. A cast iron fly wheel and wrought iron pulley of 8 ft. 6 in. diameter are keyed one at each end of the crankshaft. These drive direct on to the dynamo pulleys, the speed of the engine being 110, and that of the dynamos 720 revolutions per minute. The dynamos are shunt-wound machines, connected together in series, and furnish current to 12 of the 60 ampere lamps composing the central lusters in the Machinery Hall, that is, three lamps in series on each luster. The current on this circuit is, therefore, 240 amperes, to which 10 amperes is to be added for the lighting of three of the arc lamps in the station. The regular electrical output at 220 volts is, therefore, 55,000 watts, equivalent to 74 horse power, which at 88 per cent. industrial efficiency requires 84 horse power on the dynamo pulleys. The maximum output per machine is 33,960 watts, exciting current 8 amperes, gross weight 2 tons 4 cwt., and floor space 12 square feet.

In the engraving and plan it will be noticed that the



METER.

two belts from each of the last two engines are not the same in length, the dynamos being one slightly in front of the other. Each engine has two belt centers for its two dynamos, which are respectively 27 ft. 9 in. and 21 ft. 4 in.

The arc lamp of M. Gramme is constructed as shown in Figs. 3 and 4. The shunt electro-magnet controlling the feed is horseshoe in form, the armature being semicircular, and tending, when in its attracted position, to form a complete magnetic current through the iron. A lever, L, pivoted at V, carries the armature on its short arm, and a contact screw, M, at the extremity of its long arm. It is through the contact of this screw with a light spring, N, underneath it that the derived current reaches the coils of the electro-magnet, and, as we shall presently see, prevents overfeeding of the upper carbon. The long arm of the lever is prolonged vertically downward to form a detent to the escapement wheel of a train of clockwork, this latter being set in action by the weight of the upper carbon operating a rack rod gearing into the first wheel of the train. The lower carbon is fixed to the lower side of a rectangular frame, whose longer sides are at E E, while the upper side, C, of the frame constitutes an armature to the series electro-magnets at the top of the lamp. The adjustable springs, R R, attached to the sides of the frame, cause the armature at the top to be raised above the magnet poles and the lower carbon to be pressed upward against the upper carbon. When current is supplied to the lamp, the series coils attract this armature and cause the lower carbon to descend through an equal distance, thus striking the arc. The feed is produced by the shunt coil armature lever releasing the clockwork detent and allowing the top carbon to descend, but this movement of the lever instantly lifts the screw contact off the spring, N, and cuts off the current from the coil. The feeding action will then only recommence in case the arc is still too long. The spring, N, is prevented from following up the contact screw as it lifts by a projecting button, and, therefore, can be made of sufficient force to insure good contact with the screw. By this means the play of the armature is maintained within a limit in which the force of its attraction is proportional to the pull of the antagonistic spring. Were it not for this action, the well known rapid increase in the attractive force as the distance lessens between an armature and its magnet would cause a greater and longer movement of the armature lever than the antagonistic spring could resist, and overfeeding would result. The magnet, therefore, takes as much current as it requires to diminish the arc to its normal length, and no more. Certainly the steady burning of these lamps in the exhibition shows that there is a considerable advantage in this method of regulation.

It must be a source of satisfaction to the electricians and engineers of this station that all the machinery was in working order some ten days before the opening, and that at the anxious time immediately preceding the opening day, the erecting of plant in the Machinery Hall was carried on continuously throughout several nights by the aid of the electric light from this station.

ON THE PROPAGATION OF ELECTRIC WAVES THROUGH WIRES.

By Prof. H. HERTZ.*

IF a constant electric current flows in a cylindrical wire, its intensity is the same in all parts of the section of the wire. But if the current is variable, self-induction causes a deviation from this most simple distribution. For, since the inner parts of the wire are in the mean less distant from all the rest than are those on the circumference, induction opposes alterations of the current in the interior of the wire more strongly than at the circumference; and in consequence of this the flow is confined to the exterior of the wire. If the current alters its direction a few hundred times per second, the deviation from the normal distribution is no longer imperceptible; this deviation increases rapidly with the rate of alteration, and when the current alternates many millions of times per second, according to theory almost the whole interior of the wire must appear free from current, and the flow must be confined to the immediate neighborhood of the circumference.

In such very extreme cases the hitherto accepted theory of the phenomenon is plainly not without physical difficulties; and preference must be given to another view of the subject, which was indeed first put forward by Messrs. Heaviside† and Poynting‡ as the true interpretation of the equations of Maxwell as applied to this case. According to this view, the electric force which determines the current is in nowise pro-

* From the *Phil. Mag.* for August. Translated from Wied. *Ann.*, xxxvii., p. 395 (July, 1889), by Dr. J. L. Howard, Demonstrator of Physics in University College, Liverpool.

† Oliver Heaviside, *The Electrician*, Jan., 1885: *Phil. Mag.* [5], xxv., p. 153 (1888).

‡ J. H. Poynting, *Phil. Trans.*, II., p. 277 (1885).

pagated in the wire itself, but under all circumstances enters the wire from without and spreads itself in the metal comparatively slowly, and according to similar laws as changes of temperature in a conductor of heat. If the forces in the neighborhood of the wire are continually altering in direction, the effect of these forces will only enter to a small depth into the metal; the more slowly the changes take place, so much deeper will the effect penetrate; and if, finally, the changes follow one another infinitely slowly, the force has time to fill the whole interior of the wire with uniform intensity.

In whatever way we wish to regard the results of the theory, an important question is whether it agrees with fact. Since, in the experiments which I carried out on the propagation of electric force, I made use of electric waves in wires which were of extraordinarily short period, it was convenient to prove by means of these the accuracy of the inferences drawn. In fact, the theory was proved by the experiments which will now be described; and it will be found that these few experiments suffice to confirm in the highest degree the view of Messrs. Heaviside and Poynting. Analogous experiments, with similar results, but with quite different apparatus, have already been made by Dr. O. J. Lodge,* chiefly in the interest of the theory of lightning conductors. Up to what point the conclusions are just which were drawn by Dr. Lodge in this direction from his experiments must depend in the first place on the velocity with which the alterations of the electrical conditions really follow each other in the case of lightning.

The apparatus and methods which are here mentioned are those which I have described in full in previous memoirs.† The waves used were such as had in wires a distance of nearly three meters between the nodes.

1. If a primary conductor acts through space upon a secondary conductor, it cannot be doubted that the effect penetrates the latter from without. For it can be regarded as established that the effect is propagated in space from point to point, therefore it will be forced to meet first of all the outer boundary of the body before it can act upon the interior of it. But now a closed metallic envelope is shown to be quite opaque to this effect. If we place the secondary conductor in such a favorable position near the primary one that we obtain sparks five to six millimeters long, and surround it now with a closed box made of zinc plate, the smallest trace of sparking can no longer be perceived. The sparks similarly vanish if we entirely surround the primary conductor with a metallic box.

It is well known that with relatively slow variations of current the integral force of induction is in no way altered by a metallic screen. This is, at the first glance, contradictory to the present experiments. However, the contradiction is only an apparent one, and is explained by considering the duration of the effects. In a similar manner a screen which conducts heat badly protects its interior completely from rapid changes of the outside temperature, less from slow changes, and not at all from a continuous rising or lowering of the temperature. The thinner the screen is, the more rapid are the variations of the outside temperature which can be felt in its interior. In our case also the electrical action must plainly penetrate into the interior, if we only diminish sufficiently the thickness of the metal. But I did not succeed in attaining the necessary thinness in a simple manner; a box covered with tinfoil protected completely, and even a box of gilt paper, if care was taken that the edges of the separate pieces of paper were in metallic contact. In this case the thickness of the conducting metal was estimated to be barely $\frac{1}{20}$ millimeter. I now fitted the protecting envelope as closely as possible round the secondary conductor. For this purpose its spark gap was widened to about twenty millimeters, and in order to detect electrical disturbances in it, an auxiliary spark gap was added exactly opposite the one ordinarily used. The sparks in this latter were not so long as in the ordinary spark gap, since the effect of resonance was now wanting, but they were still very brilliant. After this preparation the conductor was completely inclosed in a tubular conducting envelope as thin as possible, which did not touch it, but was as near it as possible; and in the neighborhood of the auxiliary spark gap (in order to be able to use it), the envelope contained a wire gauze window. Between the poles of this envelope brilliant sparks were produced, just as previously in the secondary conductor itself; but in the inclosed conductor not the slightest electrical movement could be recognized. The result of the experiment is not affected if the envelope touches the conductor at a few points; the insulation of the two from each other is not necessary in order to make the experiment succeed, but only to give it the force of a proof. Clearly we can imagine the envelope to be drawn more closely round the conductor than is possible in the experiment; indeed, we can make it coincide with the outermost layer of the conductor. Although, then, the electrical disturbances on the surface of our conductor are so powerful that they give sparks five to six millimeters long, yet at $\frac{1}{20}$ millimeter beneath the surface there exists such perfect freedom from disturbance that it is not possible to obtain the smallest sparks. We are brought, therefore, to the conclusion that what we call an induced current in the secondary conductor is a phenomenon which is manifested in its neighborhood, but to which its interior scarcely contributes.

2. One might grant that this is the state of affairs when the electric disturbance is conveyed through a dielectric, but maintain that it is another thing if the disturbance, as one usually says, has been propagated in a conductor. Let us place near one of the end plates of our primary conductor a conducting plate, and fasten to it a long, straight wire; we have already seen in the previous experiments how the effect of the primary oscillation can be conveyed to great distances by the help of this wire. The usual theory is that a wave travels along the wire in this case. But we shall try to show that all the alterations are confined to the space outside and the surface of the wire, and that its interior knows nothing of the wave passing over it. I arranged experiments first of all in the following manner: A piece about 4 meters long was removed from the wire conductor and replaced by two strips of zinc plate 4 meters long and 10 centimeters broad, which were laid flat one above the other, with their ends permanently connected together. Between the strips along their middle line, and therefore almost entirely surrounded by their metal, was laid along the whole 4 meters length a copper wire covered with gutta-percha.

* Lodge, *Journ.* Soc. Arts (May, 1888); *Phil. Mag.* [5], xxvi., p. 217 (1888).

† Hertz, Wied. *Ann.*, xxxiv., p. 551 (1888).

It was immaterial for the experiments whether the outer ends of this wire were in metallic connection with, or insulated from, the strips; however, the ends were mostly soldered to the zinc strips. The copper wire was cut through in the middle, and its ends were carried, twisted round each other, outside the space between the strips to a fine spark gap, which permitted the detection of any electrical disturbance taking place in the wire. When waves of the greatest possible intensity were sent through the whole arrangement there was nevertheless not the slightest effect observable in the spark gap. But if the copper wire was then displaced anywhere a few decimeters from its position, so that it projected just a little beyond the space between the strips, sparks immediately began to pass. The sparks were the more intense according to the length of copper wire extending beyond the edge of the zinc strips and the distance it projected. The unfavorable relation of the resistances was therefore not the cause of the previous absence of sparking, for this relation has not been changed; but the wire being in the interior of the conducting mass was at first deprived of the influence coming from without.

Moreover, it is only necessary for us to surround the projecting part of the wire with a little tinfoil in metallic communication with the zinc strips, in order to immediately stop the sparking again. By this means we have brought the copper wire back again into the interior of the conductor. If we bend another wire into a fairly large arc round the projecting portion of the gutta-percha wire, the sparks will be likewise weakened; the second wire takes off from the first a certain amount of the effect due to the outer medium. Indeed, it may be said that the edge of the zinc strip itself takes away the induction from the middle of the strip in a similar manner. For if we now remove one of the strips and leave the insulated wire simply resting on the other one, we certainly obtain sparks continuously in the wire; but they are extremely weak if the wire lies along the middle of the strip, and much stronger when near its edge. Just as in the case of distribution under electrostatic influence the electricity would prefer to collect on the sharp edge of the strip, so also here the current tends to move along the edge. Here, as there, it may be said that the outermost parts screen the interior from outside influence.

The following experiments are somewhat neater and equally convincing. I inserted into the conductor transmitting the waves a very thick copper wire, 1·5 meter long, whose ends carried two circular metallic disks of 15 centimeters diameter. The wire passed through the centers of the disks; the planes of the disks were at right angles to the wire; each of them had on its rim 24 holes, at equal distances apart. A spark gap was inserted in the wire. When the waves traversed the wire, they gave rise to sparks as much as 6 millimeters long. A thin copper wire was then stretched across between the corresponding holes of the disks. On doing this, the length of the sparks sank to 3·2 millimeters.

There was no further alteration if a thick copper wire was put in the place of the thin one, or if, instead of the single thin wire, twenty-four of them were taken, provided they were placed near each other through the two holes. But it was otherwise if the wires were distributed over the rim of the disks. If a second wire was inserted opposite the first one, the spark length fell to 1·2 millimeter. When two more wires were added midway between the first two, the length of the spark sank to 0·5 millimeter; the insertion of four more wires still in the mean positions left sparks of scarcely 0·1 millimeter long; and after inserting all the twenty-four wires at equal distances apart, not a trace of sparking was perceptible in the interior. The resistance of the inner wire was nevertheless much smaller than that of all the outside wires taken together; we have also a still further proof that the effect does not depend upon this resistance. If we place by the side of the partial tube of wires, and in parallel circuit with them, a conductor in all respects similar to that in the interior of the tube, we have in the former brilliant sparks, but none whatever in the latter. The former is unprotected, the latter is screened by the tube of wires. We have in this an electrodynamic analogue of the electrostatic experiment known as the electric bird cage.

I again altered the experiment, in the manner depicted in Fig. 1. The two disks were placed so near

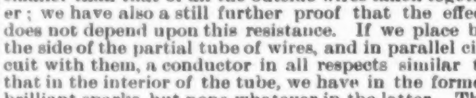


Fig. 1.

together that they formed, with the wires inserted between them, a cage (A) just large enough for the reception of the spark micrometer. One of the disks, α, remained metallically connected with the central wire; the other, β, was insulated from the wire by means of a circular hole through its center, at which it was connected to a conducting tube, γ, which, insulated from the central wire, surrounded it completely for a length of 1·5 meter. The free end of the tube, δ, was then connected with the central wire. The wire, together with its spark gap, is once more situated in a metallically protected space; and it was only to be expected, from the previous experiments, that not the slightest electrical disturbance would be detected in the wire in whichever direction waves were sent through the apparatus. So far, then, this arrangement promises nothing new, but it has the advantage over the previous one that we can replace the protecting metallic tube, γ, by tubes of smaller and smaller thickness of wall, in order to investigate what thickness is sufficient to screen off the outside influence. Very thin brass tubes, tubes of tinfoil and Dutch metal proved to be perfect screens. I now took glass tubes which had been silvered by a chemical method, and it was then perfectly easy to insert tubes of such thinness that, in spite of their protecting power, brilliant sparks occurred in the central wire. But sparks were only observed when the silver film was no longer quite opaque to light and was certainly thinner than $\frac{1}{100}$ millimeter. In imagination, although not in reality, we can conceive the film drawn closer and closer round the wire, and finally coinciding with its surface; we should be quite certain that nothing would be radically altered thereby. However actively, then, the real waves play round the wire, its interior remains completely at rest; and the effect of the waves hardly penetrates any more deeply into the interior of the wire than does the light which is reflected from its surface. For the real seat of these waves we ought not to look, therefore, in the wire, but rather to assume that they take place in its neighborhood, and instead of asserting that our waves are propagated in the wire, we should be more accurate in saying that they glide along on the wire.

Instead of placing the apparatus just described in the circuit in which we introduced waves indirectly, we can insert it in one branch of the primary conductor itself. In such experiments I obtained results similar to the previous ones. Our primary oscillation therefore takes place without any participation of the conductor in which it is excited, except at its bounding surface; and we ought not to look for its existence in the interior of the conductor.*

To what has been said above, about waves in wires, we wish to add just one remark concerning the method of carrying out the experiments. If our waves have their seat in the neighborhood of the wire, the wave progressing along a single isolated wire will not be propagated through the air alone; but since its effect extends to a great distance, it will partly be transmitted by the walls, the ground, etc., and will thus give rise to a complicated phenomenon. But if we place opposite each pole of our primary conductor in exactly the same way two auxiliary plates, and attach a wire to each of them, carrying the wires straight and parallel to each other to equal distances, the effect of the waves makes itself felt only in the region of space between the two wires. The wave progresses solely in the space between the wires. We can thus take precautions to propagate the effect through the air alone or through another insulator, and the experiments will be more convenient and free from error by this arrangement. For the rest, the lengths of the waves are nearly the same in this case as in isolated wires, so that with the latter the effect of the disturbing causes is apparently not considerable.

3. We can conclude from the above results that rapid electric oscillations are quite unable to penetrate metallic sheets of any thickness, and that it is, therefore, impossible by any means to excite sparks by the aid of such oscillations in the interior of closed metallic screens. If, then, we see sparks produced by such oscillations in the interior of metallic conductors, which are nearly but not quite closed, we shall be obliged to conclude that the electric disturbance has forced itself in through the existing openings.

This view is also correct, but it contradicts the usual theory in some cases so completely that one is only induced by special experiments to give up the old theory in favor of the new one. We shall choose a prominent case of this kind, and by assuring ourselves of the truth of our theory in this case, we shall demonstrate its probability in all other cases.

We again take the arrangement which we have described in the previous section and drawn in Fig. 1; only we now leave the protecting tube insulated from the central wire at δ. Let us now send a series of waves through the apparatus in the direction from A toward δ. We thus obtain brilliant sparks at A; they are of similar intensity to those obtained when the wire was inserted without any screen. The sparks do not become materially smaller if, without making any other alteration, we lengthen the tube, γ, considerably, even to 4 meters.

According to the usual theory, it would be said that the wave arriving at A penetrates easily the thin, good-conducting metal disk, α, then it leaps across the spark gap at A, and travels on in the central wire. According to our view, on the contrary, we must explain the phenomenon in the following manner:

The wave arriving at A is quite unable to penetrate the metallic disk; it therefore glides along the disk over the outside of the apparatus and travels as far as the point, δ, 4 meters away. Here it divides: one part, which does not concern us at present, travels on immediately along the straight wire, another bends into the interior of the tube and then runs back in the space between the tube and the central wire to the spark gap at A, where it now gives rise to the sparking. That our view, although more complicated, is still the correct one, is proved by the following experiments:

First, every trace of sparking at A disappears as soon as we close the opening at δ, even if it be only by a stopper of tinfoil. Our waves have only a wave length of 3 meters; before their effect has reached the point, δ, the effect at A has passed through zero and changed sign. What influence, then, could the closing of the distant end, δ, have upon the spark at A, if the latter really happened immediately after the passage of the wave through the metallic wall?

Secondly, the sparks disappear if we make the central wire terminate inside the tube, γ, or at the opening, δ, itself; but they reappear when we allow the end of the wire to project even 20 to 30 centimeters only beyond the opening. What influence could this insignificant lengthening of the wire have upon the sparks in A, unless the projecting end were just the means by which a part of the wave breaks off and penetrates through the opening, δ, back into the interior?

Thirdly, we insert in the central wire between A and δ a second spark gap, B, which we also completely cover with a gauze cage like that at A. If we make the distance of the terminals at B so great that sparks can no longer pass across, it is also no longer possible to obtain visible sparks at A. But if we hinder in like manner the passage of the spark at A, this has scarcely

* The calculation of the self-induction of such conductors on the assumption of uniform density of current in their interior must therefore lead to quite erroneous results. It is to be wondered at that the results obtained with such wrong assumptions should still appear to approximately coincide with truth.

any influence on the sparks in B. Therefore the passage of the spark at B determines that at A, but the passage of a spark at A does not determine that at B. The direction of propagation in the interior is therefore from B toward A, not from A to B.

We can moreover give further proofs, which are more convincing. We may prevent the wave returning from δ to A from dissipating its energy in sparks, by making the spark gap either vanishingly small or very great. In this case the wave will be reflected at A, and will now return again from A toward δ.

In doing so it must meet the direct waves from δ to A and combine with them to form stationary waves, thus giving rise to nodes and ventral segments. If we succeed in proving their existence, there will be no longer any doubt as to the truth of our theory. For this proof we must give somewhat different dimensions to our apparatus in order to be able to introduce electric resonators into its interior.

I, therefore, led the central wire through the axis of a cylindrical tube 5 meters long and 30 centimeters diameter. It was not constructed of solid metal, but of 24 wires arranged parallel to each other along the generating surface, and resting on seven equidistant and circular rings of strong wire, as shown in Fig. 2. I made the requisite resonator in the following manner:

A closely wound spiral of 1 centimeter diameter was formed from copper wire 1 millimeter thickness; about

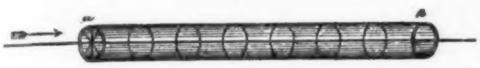


FIG. 2.

125 turns of this spiral were taken, drawn out a little, and bent into a circle of 12 centimeters diameter; between the free ends an adjustable spark gap was inserted.

Previous experiments had shown that this circle responded to waves 3 meters long in the wire, and yet it was small enough in size to admit of its insertion between the central wire and the surface of the tube. If now both ends of the tube were open, and the resonator was then held in the interior in such a way that its plane included the central wire, and its spark gap was not directed exactly inward or outward, but was turned toward one end or the other of the tube, brilliant sparks of ½ to 1 milimeter length were observed.

On now closing both ends of the tube by four wires arranged crosswise and connected with the central conductor, not the slightest sparking remained in the interior, a proof that the network of the tube is a sufficiently good screen for our experiments.

The end of the tube on the side, β, that, namely, which was furthest away from the origin of the waves, was now removed. In the immediate neighborhood of the closed end, that is at the point, a, which corresponds to the spark, A, of our previous experiments, there were now no sparks observable in the resonator. But on the moving away from this position toward β, sparks appeared, became very brilliant at a distance of 1·5 meter from a, then decreased again in intensity; they almost entirely vanished at 3 meters distance from a, and increased again until the end of the tube was reached.

We thus find our theory borne out by fact. That we obtain a node at the closed end is clear, for at the metallic contact between the central wire and the surface of the tube the electric force between the two must necessarily vanish.

It is different when we cut the central conductor at this point near the end, and insert a gap of several centimeters length. In this case the wave will be reflected in a phase opposite to that of the previous case, and we should expect a ventral segment at a. As a matter of fact we find brilliant sparks in the resonator in this case; and they rapidly decrease in strength if we move from a toward β, they almost entirely vanish at a distance of 1·2 meter, and become brilliant again at a distance of 3 meters; moreover, they give a second well-marked node at 4·5 meters distance, that is, 0·5 meter from the open end.

The nodes and loops which we have described are situated at fixed distances from the closed end, and alter only with this distance; they are, however, quite independent of the occurrences outside the tube, for example, of the nodes and loops formed there. The phenomena occur in exactly the same way if we allow the wave to travel through the apparatus in the direction from the open to the closed end; their interest is, however, smaller, since the mode of transmission of the wave deviates from that usually conceived, less in this case than in the one which has just been under our consideration.

If both ends of the tube are left open with the central wire undivided, and stationary waves with nodes and loops are now set up in the whole system, there is always found, for every node outside the tube, a corresponding node in the interior; which proves that the propagation takes place inside and outside with, at any rate approximately, the same velocity.

On looking over the experiments which we have described, and the interpretation put upon them, as well as the explanations of the physicists referred to in the introduction, a difference will be noticed between the views here put forward and the usual theory.

According to the latter, conductors are represented as those bodies which alone take part in the propagation of electric disturbances; non-conductors are the bodies which oppose this propagation. According to our view, on the contrary, all transmissions of electrical disturbances are brought about by non-conductors; conductors oppose a great resistance to any rapid changes in this transmission.

One might almost be inclined to maintain that conductors and non-conductors should, on this theory, have their names interchanged. However, such a paradox only arises because one does not specify the kind of conduction or non-conduction considered. Undoubtedly metals are non-conductors of electric force, and just for this reason they compel it under certain circumstances to remain concentrated instead of becoming dissipated, and thus they become conductors of the apparent source of these forces, electricity, to which the usual terminology has reference.

Karlsruhe, March, 1889.

AN ELECTRO-PLATING DYNAMO.

By GEO. M. HOPKINS.

THE electro-plating dynamo differs from an electric lighting dynamo chiefly in its winding. For metallurgical work a large current of low voltage is required. For electrotyping, an electro-motive force of three to

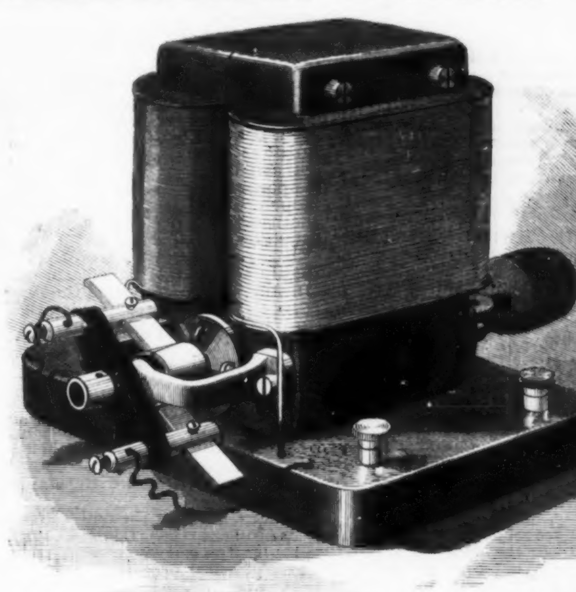


FIG. 1.—ELECTRO-PLATING DYNAMO.

four volts is sufficient, while for nickel plating it should run up to about six volts, and for silver plating to about five.

In a small dynamo, like the one illustrated in Fig. 1, it is impossible to secure as wide a range of electromotive force or of current as can be realized in a larger machine, but by varying the speed and by introducing more or less resistance in the external or internal circuit, the current can be adapted to most uses of the amateur. In the construction of this dynamo all of the dimensions of the cores and polar extremities of the field magnet and of the armature core, as given in the description of the hand power dynamo in SUPPLEMENT, No. 161, are followed except in regard to the thickness of the waists of the field magnets and their polar extremities. These dimensions are

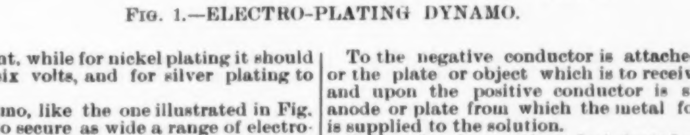


FIG. 2.—ARMATURE OF ELECTRO-PLATING DYNAMO—HALF SIZE.

here increased by adding ⅛ inch to the thickness of the waists and ¼ inch to the thickness of the polar extremities, thus increasing the amount of iron in the field magnet.

The armature is wound with five layers of No. 12 cotton-covered magnet wire, and the terminals of the coil are connected with the halves of the commutator cylinder as shown in Fig. 2.

The commutator cylinder is formed of two sections cut from a copper tube and mounted upon a hub of vulcanite, or vulcanized fiber, the tube sections being separated from each other so as to form diagonal slits in diametrically opposite sides of the cylinder, as shown.

The brushes are supported by mortised studs inserted in the ends of a cross bar of vulcanized fiber mounted on the journal box of the armature shaft. The thread-

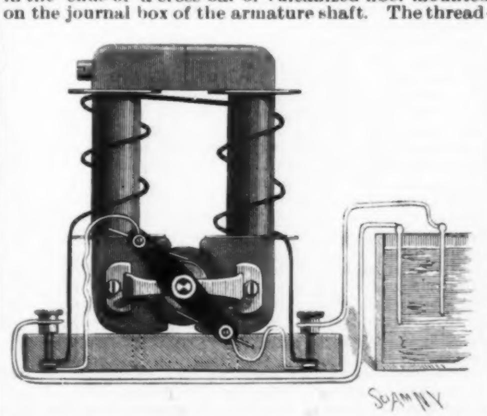


FIG. 3.—CONNECTIONS OF PLATING DYNAMO.

ed ends of the mortised studs project through the cross bar to receive binding posts which are screwed down tightly on the bar. In the mortises of the studs are placed the brushes, which press lightly upon the commutator cylinder. The brushes are formed of several thicknesses of thin hard-rolled copper.

The field magnet is wound with 12 layers of No. 18 magnet wire, and is connected as a shunt to the armature. That is to say, the terminals of the field magnet wires are connected with the same binding posts that receive the wires from the commutator brushes, as shown in Fig. 3.

The conductors of the external circuit are also connected with these binding posts. When the connections are arranged in this way, the current divides at the binding posts referred to, a part going through the wire of field magnet, another part going through the external circuit, which in the present case includes a plating solution.

To the negative conductor is attached the cathode or the plate or object which is to receive the deposit, and upon the positive conductor is suspended the anode or plate from which the metal for the deposit is supplied to the solution.

Unless the dynamo is at first started with a battery in circuit, it will be impossible to tell, without a test of some sort, which is the positive and which the negative binding post. This can be determined in a moment by trial in the plating solution.

If on starting the machine a deposit is made on the cathode, the connections are correct. If, however, no deposit appears, the conductors should be transposed either at the dynamo or at the plating bath.

Large wire should be used for carrying the current. Within certain limits the electro-motive force of the current may be varied by changing the speed of the machine, and the current may be controlled by inserting resistance into the external circuit or into the shunt.

The hand power dynamo referred to above may be converted into a shunt machine by arranging the connections according to Fig. 3, but it will be necessary to introduce resistance into the shunt or field magnet circuit to prevent too much current from going through the field magnet.

The electro-plating dynamo may be used successfully in copper, nickel, and silver plating on a small scale, also for electrotyping.

The length of wire on the armature is 40 feet, and on the field magnet about 500 feet.

THE SIDERO CEMENT PIPE.

AMONG the numerous exhibits in and about the French exposition buildings is to be found that of J. L. Bornave, whose specialty is the manufacture of what is termed Sidero cement pipe. For several years there have been manufactured in France different styles of cement pipes for water and sewer work, with a framework of wire netting or wire rods incased in the cement. This is also used for tanks and watering troughs. But all these could not stand high pressures, and were liable to deformation and cracks from springing. This new system of M. Bornave consists in having a frame made of small I rods of steel from one-half to one inch in height, and a thickness of $\frac{1}{16}$ to $\frac{1}{12}$ inch. The rods are wound spirally on a special machine, and similar rods are laid longitudinally inside and made fast by wire. This frame is then set up on end, bell end down, a core is placed inside and a casing outside, then the cement is run in gradually, allowing all the air to rise to the top. When finished, the thickness is one inch or less, usually.

In practice the pipe is made on the ground where it is to be used. All the material is shipped in bulk, and the necessary machinery, which is easily handled, is moved from place to place as needed.

For each special case the size of iron is calculated, as also the thread of the spiral to which it is wound, so as to use as little as necessary. But all the strain is considered as bearing on the iron, and the cement acts only to close the openings. Where bell joints are used, the rods are closer together at the bell, so as to stand strain of calking a lead or cement joint.

The following claims are made for it: The expansion of the steel and the cement under different temperatures in practice is about the same—0·000014349 for the cement and 0·000011899 for the steel. When finished, the pipe is lighter than cast iron and less ex-

pensive, is not attacked by the water, and does not rust or stop up.

For a head of from 15 to 20 meters (50 to 67 feet) the comparative cost in Paris is said to be as follows :

12 inch pipe of cast iron,	19 frs.	per meter ;	Sidero	cement,	15 frs.	
16 " "	27 "	"	"	"	22 "	
20 " "	37 "	"	"	"	27 "	
24 " "	46 "	"	"	"	37 "	
28 " "	58 "	"	"	"	46 "	
36 " "	80 "	"	"	"	61 "	
48 " "	136 "	"	"	"	84 "	

The flanges of the I rods make a tie in the cement that does not exist with round or square rods. The mode of manufacture allows of varying the strength of the pipe as required.

This pipe has been used for about a year, some specimens having been used for reservoirs which had a measurement of 25 meters (82 feet) in diameter. It may be made for sewer sections, elliptical, oval, or any other shape.

THE ORIGIN OF THE METRIC SYSTEM.

By WALTER B. SCAIFE, Ph.D.

A CENTURY ago not only did each country have its own independent system of weights and measures, but almost every important city set up its own standard with perfect indifference to those of its neighbors. The result was increase of labor in all mathematical scientific investigations, and confusion and loss of time in commercial transactions. As recognized standards, we find, for example, the foot of Paris, Denmark, Leyden on the Rhine, London, Sweden, Rome, Bologna, Dantzig, Amsterdam, Naples, Genoa, and Palermo, each one different in length from all the rest, and showing a variation from the longest (Bologna) to the shortest (Palermo) of 60·9 Paris lines, equal to 5·4 English inches.

Men of learning had long recognized the need of reform, and various suggestions were made from time to time to seek a standard founded in nature which would be universal and unalterable. Thus in 1671 Picard, known from his measurement of a degree of latitude, from whose results Newton was first enabled to prove his theory of gravitation, proposed as such a standard the length of a pendulum beating seconds, to which he would apply the name "astronomical ray."

The scientific world was first to learn a little later that the length of such a pendulum varies with the latitude.

The famous Italian astronomer and founder of the French royal observatory under Louis XIV., Jacques Cassini, advocated another theory (1720), viz., that as unit of measure should be established a "geometrical foot," to be the six-thousandth part of a minute of arc of a great circle, or else a pair of such feet, which would be one ten-millionth part of the radius of the earth (N. B.—He supposed the earth to be a perfect sphere), or finally a "toise" of six such feet, making 60,000 toises to the degree. Other units have also been proposed, as that of Sir Humphry Davy, viz., the diameter of a tube in which a fluid would rise as high as the tube was wide ; or that of Andreas Bohm, the distance a falling body traverses in a second ; or Mouton's, that a mile should equal a minute of arc ; or later still, the length of a wave of sodium light.

Whatever standard is sought, the result must depend for accuracy on the mechanical skill of those making the instrument which is to be the standard unit of comparison, so that, as a recent writer remarks, "A natural standard is only a matter of sentiment." However, the French revolutionists of 1793 did not think so, but in their zeal for universal reform were very ready to listen to Talleyrand when he moved the Constituent Assembly to invite the Academy of Sciences to found a system of weights and measures on a natural basis.

He had not yet become "the most shrewd, subtile, and unprincipled of modern diplomatists," but through family influence had been appointed to the rich bishopric of Autun, and as such, now in his fortieth year, sat in the Assembly as the representative of the clergy of his diocese.

The bill was later favorably reported by the committee to which it had been referred, and May 8, 1790, was issued a decree by which the king was requested to ask the king of Great Britain to appoint members of the Royal Society to confer with a commission composed of members of the French Academy of Sciences "for the establishment of a natural unit of weights and measures."

The length of a pendulum beating seconds on the forty-fifth parallel of latitude was suggested as the unit.

Among the French commissioners we find Laplace, Legrange, and Condorcet, and later, as co-operator, Lavoisier, names which give sufficient guarantee of the standard of excellence aimed at. They abandoned the idea of the pendulum standard, on the ground that "it is indeed much more natural to compare the distance from one place to another with the quarter of one of the terrestrial circles than with the length of a pendulum.

Opinions differed as to whether the equator or a meridian should be used as the base of operations. The latter was considered by the majority the more practicable, and the report above quoted says : "The fourth of the earth's meridian should indeed be the real unit of measure, and the one-ten-millionth part thereof might serve as the usual unit."

The commission did not wait for co-operation from England, saying in justification of its action : "In fact, we have excluded from this choice [of a standard] every arbitrary determination, and have admitted only elements which pertain equally to all nations ;" adding thereto : "There is indeed nothing here which could give the slightest pretext to the reproach of having wished to bring about any sort of pre-eminence." March 26, 1791, the Legislative Assembly decreed the acceptance of the Academy's propositions ; the royal approval followed on the thirtieth, and the Academy was empowered to name the commissioners to execute the work.

As we have seen, the foundation of the whole system was to be the length of a fourth part of the earth's circumference, drawn through the poles. Such a circumscribing line forms an ellipse, on account of the flattening of the earth at the poles. Of course it is not possible to make an actual measurement from the equator to the poles ; but if the length of a portion is known, and the relation of that portion to the whole, the value of the whole can be easily deduced. Only a comparatively short line is actually measured on the earth's surface, which is connected by triangulation with points, at a much greater distance from each other, on the meridian. The proportion of the distance between these points to the entire circumference of the earth is then determined by astronomical observations.

There had already been made in France and elsewhere several careful surveys, in order to determine the length of the earth's circumference. As the object now in view was to establish once for all an unalterable standard of measure taken from nature herself, it was considered necessary to undertake such a survey on a scale hitherto unknown, with an exactitude as great as scientific ingenuity could devise and mechanical skill execute. The instruments to be used for this important work were made with the greatest care. Among these may be mentioned as worthy especial notice several circles of Borda for the measurement of angles, and the rules for measuring the base lines. These rules were also invented by Borda, and were so nicely adjusted as to measure exactly (according to Delambre) the hundred-thousandths of a toise (six French feet), and from which the millionths could be deduced, with a probable error of not more than two or three.

The actual work of the survey was intrusted to Mechani and Delambre, well known astronomers of the day, whose unselfish devotion to their science was sufficiently proved in the trials they uncomplainingly endured while engaged in this important undertaking.

The making of the instruments and other preparations occupied more than a year. Meanwhile all France had become agitated with the progress of the revolution.

Four days after the mob's first invasion of the Tuileries (June 24, 1792), Louis XVI. issued a proclamation placing the surveyors and their instruments under governmental protection. But the instruments were not yet completed, and the surveyors were accordingly prevented from setting out till September. In the meantime the fatal 10th of August had come and gone, and the power of the king was a thing of the past. His safe-conducts were therefore rather a cause of suspicion than a protection.

The meridian determined upon as best adapted for measurement was the one passing through Dunkirk and Barcelona, as the line connecting these two points crosses the forty-fifth parallel of latitude, the middle distance between the equator and the north pole, and afforded the longest available stretch from north to south.

Mechani, who had undertaken the measurement of the southern portion of the line, set out first, was arrested by the citizens at his third post, and only gained his freedom through the friendly exertions of the magistrates.

Later, when France and Spain were at war, he was detained in the latter country, and the money which had been provided for his expenses, and deposited in Spain, was confiscated as French property. Personal liberty was, however, accorded him, and he occupied his time in making astronomical observations and mathematical calculations connected with the survey. After the lapse of some time, and a change of ministry in Spain, he was permitted to go to Italy, and made his way thence back to his native land. But the trials and hardships had been too severe for his constitution ; and, weak and suffering, he returned to work, only to die at his post.

Delambre, to whom the northern survey was assigned, had many disagreeable experiences, one of which at least threatened to have a tragic ending. He was stopped one day at Epinai on the ground that his instruments were not described with sufficient explicitness in his passports. He was compelled to unpack his instruments and explain their uses, although "no one listened to the demonstration that I made, and it was necessary to recommence for each person who came up."

This state of affairs continued three hours, when he was taken under armed escort to St. Denys. Here he had even a harder time of it, and was concealed for a time by the magistrates to save him from the imminent violence of the mob. He had not only to submit again to an investigation of his instruments and to the trouble of making a long speech, which was not listened to, but also to the opening of his letters of recommendation to the various authorities along the route of his proposed work. The crowd was becoming more and more boisterous, and night was falling when the happy idea occurred to the president of the district to propose to the mob to postpone further examination till morning. The instruments, papers, etc., were placed under official seal, as a matter of form. Next day, instead of continuing the matter with the mob, a letter was sent to the National Convention, then in session at Paris, where a decree was pushed through recommending Delambre and his party to the protection of the local authorities.

This was brought to St. Denys on the third day, and Delambre, who had meantime judiciously remained concealed, was permitted to depart without further molestation.

The interferences of ignorant peasants were not the only trials to which they were subjected ; for wind and fog, rain and snow, combined to render almost unendurable the hardships to which these really heroic devotees of science submitted in carrying out their noble work.

Some idea of the carefulness and exactness of the work may be gained from the following facts : From their respective observatories, Delambre and Mechani each made 1,800 observations of the altitude of the pole star, in order to determine astronomically the exact position of the Pantheon of Paris, which formed a point of one of their triangles. The result showed an accordance of at least the one-sixth of a second of arc. In measuring the base lines, the greatest result for one day of nine hours' hard labor was the measurement of 360 meters, or placing ninety times one rule before the other. In this careful manner were two base lines measured, each more than 6,000 toises, or about 7½ miles long.

After accounting for all known possible sources of error, Delambre calculated that, taken together, they would not amount to more than one two-hundred-thousandth of the distance measured. By most careful triangulation these base lines were connected with the meridian arc passing through Dunkirk and Barcelona, distant from each other 9° 40¾'. From the result thus obtained the length of the quadrant from the equator to the north pole was calculated by different savants employing different methods ; and the one ten-millionth part of this distance = 443.296 lines, was adopted as the "usual unit" of measure, with the name *metre*.

An invariable standard of measure has been sought, but not found. Later calculations, based on more reliable data, give different results for the length of the earth's meridian quadrant, and do not agree among themselves. Perhaps the most generally accepted is that of the German mathematician Bessel, who, combining the results of all the leading surveys made to date, determined in 1841 the quadrant to be 10,000,856 meters long, which makes the standard meter 0·0000856 too short.

The main feature, however, of the metric system, and that which has led to its extensive adoption, is its decimal division and multiplication, instead of the elsewhere usual duodecimal, by which means scientific work has been greatly lightened and commercial transactions simplified. Another advantage of the metric system is the relation established between length, volume, and weight, the determination of which could not be carried out until after the unit of linear measure had been fixed. For surface and solid measurements, the square and cube respectively of the linear unit were adopted as the standard.

To establish a relation between the linear unit and weight presented many difficulties. It was necessary to secure, therefore, a substance which may be easily handled, which is at the same time constant in its chemical and physical action, and which is always obtainable, in order to make possible the re-establishment of the standard, in case the first one made should by any accident be lost.

After long deliberation the commission decided to adopt the weight of a certain quantity (a cubic decimeter) of distilled water at its greatest density. But to obtain a vessel which would contain or displace just so much was no easy matter. The form determined upon was a right cylinder with the diameter equal to its height. One such was made of brass, with the utmost care ; and for measuring it there was constructed a special apparatus capable of measuring to the 1-2000 of a Paris line, and making appreciable one-fourth that quantity, in differences in its various dimensions.

The nicety of the experiments cannot be better described than in the words of M. Tralles, whose duty it was to witness them and make a report thereon to the commission of weights and measures. He says : "There were drawn on the base of the cylinder twelve radii, or six diameters, which divided it into twelve equal parts. Each of these diameters had one parallel to it in the other base. At about eleven millimeters from the circumference a point is marked on each one of these radii, also at the middle, and at two-thirds of their length toward the center.

"In these 36 points and at the center, Citizen Lefevre-Ginau observed the heights, in measuring their distances to the 37 similar points on the other base. Each of these heights was measured several times, and the greatest differences which Citizen Lefevre-Ginau met did not exceed 0·0035 of the ancient line, but ordinarily they reach only 0·0015. It is indeed very probable that the mean result of from ten to twelve observations for each height, which the commissioners believed should be adopted without excluding any, would be exactly 0·0005."

Eight circles parallel to the bases, and measured with the same careful precision, showed even better results. "Taking either the greatest or the least diameter in place of the mean, there would be an error of but 0·0001 in the volume."

Without entering into further detail, it may be worth while to state that this cylinder was weighed with extreme care 48 times in water and 53 times in a vacuum. "The result was that the true kilogramme or the cubic decimeter of distilled water, at the maximum of density, weighs 18827·15 grains in a vacuum." "It cannot be doubted that the experiments made . . . are of the highest degree of exactness at which we can arrive."

In order to convince the civilized world of the utility and exactness of the new units of weights and measures, all governments friendly or neutral to France were invited to send representatives to an international commission at Paris to investigate the methods and results of the work done.

The Napoleonic wars being then in full swing, England, Russia, Prussia, and Austria were naturally not included in this invitation. However, Spain, Denmark, Holland, and several states of Italy sent savants thither, and to these, united with the French commissioners, the different sub-commissions to whom the practical execution of this laborious undertaking had been intrusted made their several reports and submitted their work in its minutest detail for examination and criticism. Accepted by these, it was also accepted by the French political authorities, who declared the units thus determined to be the fixed and legal standards of France forever.

We have seen that the theoretical meter is not exactly what it purports to be, viz., the one ten-millionth of the meridian quadrant ; so, too, it was discovered some years since that the standard bar of platinum preserved at Paris for comparison was not exactly what it was intended to be, but about 1-1000 of a Paris line too short ; so a new one of platino-iridium was made, which is now in the keeping of the International Metric Commission at Paris. The old one was an end standard, or a bar whose entire length was the unit ; the new one is a line standard, *i. e.*, a bar 40 inches long, on which the true length of a meter is marked by lines on gold pins set in the body of the bar, so that slight bending of the bar will not alter their distance from each other.

Up to 1840 there were various systems of divisions and multiplications of the standards, as well as names therefor, tolerated in France ; but since the 1st of January of that year the present pure decimal system has been enforced ; since which time the metric system has made great advances in the favor it has found with other nations.

If any system of weights and measures is to become universal, this seems to be the one destined thereto, not because it is founded in nature, as its orginators

hoped to make it, but because it is reasonable, convenient, simple, and, above all, practical. It is now in general use in Germany, Austria, Italy, Spain, Norway and Sweden, Holland, Belgium, Switzerland, Portugal, and on this side of the Atlantic in Mexico, Venezuela, and the Argentine Republic, not to speak of Hayti and other islands. Its use is allowed in the United States and Great Britain, and its enforcement in these countries would probably lead to the speedy universal adoption of the system.

HOW TO MAKE RELIEF OR PRINTING PLATES.

THE JOYCE PROCESS.

By Maurice Joyce, Washington, D. C.

I TAKE a smooth metallic plate, which is covered with a thin coating of clay, plaster, or equivalent material applied in a plastic state.

I usually employ a mixture of ground potter's clay and plaster of Paris, nearly equal parts, moistened with water to the consistency of mortar, but ground soapstone, chalk, or other material may be used instead.

The material is spread upon the metal plate and scraped down to any desired thickness, accordingly as lines are required in high or low relief, the thickness of the coating determining the relief elevation of lines in the finished plate.

I usually dry the plaster coating before any portion is cut away, but this is not essential.

My design may be penciled, traced, or transferred upon the surface of the plaster, or an artist sufficiently skilled may work without any copy. The coating is then cut away for the lines, entirely through to the metallic plate.

Points, needles, gravers, etc., may be used for cutting or scratching away the material. When the design has been completed, the lines are cleaned out with a soft brush, or blown out with a bellows.

The plate at this stage of the operation resembles a mould for a stereotype plate as used in the clay or plaster process of stereotyping, except that the lines and letters are cut entirely through the plaster.

The mould or matrix is now made ready, and a metal stereotype plate cast upon it in any manner usual in the stereotyper's art. This plate is finished up in the ordinary manner, and if more relief is desired for the lines, the low portions of the plate may be cut or routed out.

Door plates and other ornamental relief line plates may be made in the same manner.

My invention enables me to produce relief line plates in a very short time. It is especially adapted for the speedy reproduction of plates for maps, diagrams, plans, etc.

THE HOKE OR STAR PROCESS.

By Joseph W. Hoke, St. Louis, Mo.

The base plate of my improved engraving plate for stereotyping purposes is preferably a polished blued steel plate of suitable superficies. It withstands the heat incident to stereotyping, and its tint, when a light-colored coating is used, presents a marked and agreeable contrast to the coating and enables the engraver to readily judge the effect of his work. For electrotyping purposes a base plate of glass is preferred. Glass is also an excellent material in combination with the special coating preferred by me and hereinafter described, and its transparency enables the engraver to examine his work by holding the plate to the light.

For the coating of the plate a finely powdered material—such as a finely powdered earth or mixture of earths or other equivalent finely powdered inorganic substance or substances which will withstand the heat of molten stereotyping metal—is used. The more thoroughly and evenly the material is comminuted, and the more marked the contrast in color between the coating and the base plate, the better is the engraving plate adapted for the purpose in view.

The leading features of the improvement are that the particles of the coating next to the base plate adhere thereto more strongly than the particles above them adhere either to them or to each other, and that the coating is very friable and the particles thereof very loosely as well as very evenly bonded together, so that they readily separate without caking and without breaking away between the lines when the plate is engraved; bonding the particles of the coating to each other and to the base plate with soluble glass or an equivalent soluble mineral alkaline bond; bonding the particles of the coating to each other and to the base plate by treating the particles with a solution of soluble glass or equivalent soluble mineral alkaline solution, and then baking the coated base plate until the coating is dried; mixing together the ingredients to be bonded, then adding a water glass in solution or an equivalent solution of a soluble mineral alkaline substance, and then baking or subjecting a base plate coated with the mixture to a heat beneath the boiling point and not under 100° Fahrenheit until the coating is solidified, after which the heat may be increased without injury to the coating; the special combination of substances given in the formula is used to form the coating upon the base plate.

In engraving a design in the matrix, it is highly desirable that the engraver shall be able to see distinctly the lines made through the coating, and thereby judge correctly the work being done. To this end the coating is made white or light-colored, while the surface of the base plate appears dark, and the end is more effectually attained by employing a blued still plate for the base plate.

My improved coating, whose most desirable constitution is stated in the following formula: Of sulphate of barium (barytes), take two drachms; of silicate of magnesia (French chalk), take one drachm; of silicate of soda, take four drops; and of water, take five cubic centimeters. This mixture will cover sufficiently thick six square inches of plate.

The more perfectly it is mixed, the better the plate. A good way to make the mixture is first to mix the earth or earths in a finely pulverized form with water, and work and rub the ingredients in a mortar until the mixture becomes smooth, and then add the solution of soluble glass and mix it with the other ingredients as thoroughly as practicable. The mixture should then be spread evenly over the base plate, shaking it slightly to settle the coating evenly. The coating should, after being placed on the plate, be dried by heat beneath the boiling point, and not lower than 100° Fahrenheit, and preferably between 180° and 190° Fahrenheit, until it solidifies, after which the heat may be increased as high as 300° Fahrenheit without injury to the coating. The object in keeping the heat beneath the boiling point while the coating remains in a semi-liquid state is to prevent its boiling. The coating should be thoroughly dried. The coating at its top is usually incrusted, and after the plate has cooled and before it is engraved, the crust should be scraped off and the coating made of a uniform depth over the surface of the base plate.

When the coating is mixed very slowly, it may be baked at once; but otherwise it should be allowed to stand after mixing for at least five minutes before baking, and is rather improved by being allowed to stand longer. The object in allowing it to stand before baking is to allow the air contained in the mixture to escape as far as possible and to prevent the coating from curling up and cracking while being dried.

The above method of mixing and baking is not the only one that can be used. The essential points are first to introduce the bond in the form of a solution into the body of the coating, and then dry the coating upon the plate.

Instead of mixing the bond with the water and earths in the manner above described, the mixture may be made without the bond and dried, with or without artificial heat, upon the base plate, and the coating may then be saturated with a solution of silicate of soda containing from twenty-five to fifty drops of silicate of soda to an ounce of water, and then baked as first above directed. In this process I prefer to use twenty-five drops of the silicate of soda to an ounce of water.

Though I consider the formula for the coating above given the best, it may be widely departed from and good results still obtained, so long as the bond is of the proper nature and is used in the proper proportion. I prefer to use the earths named in the formula (silicate of magnesia and sulphate of barium) and in the proportions given; but the proportions may be varied indefinitely, and good, though inferior, plates made. Either silicate of magnesia or sulphate of barium may be used alone in place of the mixture, though not so good. Sulphate of barium is somewhat undesirable when used alone, because a coating made of it has a tendency to crack in drying.

Among the substances which I call "earths" is silica, sometimes called an "acid;" but for my purposes it has all the qualities of an earth, and I find the silicious rocks especially valuable.

All kinds of light-colored earths may, when finely powdered, be used in lieu of the ones named in the above formula, though they are far from being equally good. Those which have the least attraction for water are the best. The clays are perhaps the least desirable of all, because of their tendency to crack when drying. It is desirable where they are used to mix them with an equal bulk of plaster of Paris or with some other substance which will prevent cracks, as the bond will not perform that function when used in the proper proportion.

The most desirable earths—naming them in their order of merit—are, in my opinion, the following: soapstone, tripoli, talc, quartz, and chalk. They may be used singly or in combination with each other or other white earths not named. Sulphate of barium, though excellent when mixed with silicate of magnesia, is not so good as the substances named above when used singly. I have obtained my best results by mixing a very light with a very heavy earth, and consider that a good course to follow. I consider the specific gravity of a mixture of sulphate of barium and silicate of magnesia in the proportions named in the formula given the most desirable, and in selecting an earth or making a mixture of earths an attempt to approximate the same specific gravity should be made.

I have given the proportions of silicate of soda and water which I prefer to use with the mixture of earths given in the formula; but both water and the bond may be used in different proportions, though the results will not be so good. From four to six cubic centimeters of water and from one to fourteen drops of silcate of soda may be used with the mixture of earths given in the formula. Where, however, less than two drops of bond are used, the plate is very poor, because insufficiently bonded. Where more than eight drops are used, the coating is made too hard to be entirely satisfactory, and is more or less liable to break away from the base plate when being engraved.

The silicate of soda which I have used and which I have taken as a standard in making out the formula given is the solution known commercially as "pure" silicate of soda. It is not necessary that it should be strictly chemically pure. It sometimes differs somewhat in density and purity from the usual standard; but I have never known it to differ enough to make the above formula and directions inapplicable.

What is commercially known as "pure" solution of silicate of potash, and which shares the name of "soluble glass" with "silicate of soda," is a strict chemical equivalent of silicate of soda, and may be substituted for it and the same proportions used where the solution is of the same specific gravity as the pure solution of silicate of soda. There are also other soluble alkaline mineral equivalents of silicate of soda, as is well known.

The following rule may be taken as a guide in using the bond and water with other earths or mixtures of earths than the mixture prescribed in my formula: The amount of bond and water used should be the same as for an equal bulk of the mixture of earths given in the formula. This rule is not exact, because the chemical character of the different earths varies; but it will answer for practical purposes. Another test as to the amount of water to be used is that the mixture when made should be thin enough to pour out of a containing vessel, but no thinner than necessary for that purpose. It should be of about the consistency of batter, so that a small portion will cling to the side of the vessel from which it is poured. Clay is an exception to the general rule as to the amount of water necessary. Where it is used, only one-half the quantity of water necessary for other substances should be used.

Where more water than I have directed to be used is used, the earths settle to the bottom and the larger portion of the bond remains on top, so that there is an insufficient amount of bond near the base plate unless an unnecessary amount of bond is used. The amount of bond directed to be used is what should be embodied in the coating.

THE HANSEN PROCESS.

By Christian H. Hansen, Washington, D. C.

Provide a smooth level plate of some suitable hard material and of a size somewhat exceeding that of the engraving which it is desired to produce. A piece of plate glass will answer admirably; but any other suitable material may be substituted. The face of this plate is covered with a thin coating of tallow, lard, oil, beeswax, or with some suitable compound ointment, preferably of an unctuous character, which shall admit of being spread evenly upon the base plate, and which shall enable a sheet of tinfoil to adhere to the composition on said plate with such a degree of tenacity as to prevent it from being displaced when manipulated.

The tinfoil, having been attached to the composition on the plate, is ready for the draughtsman or artist, who, with a style, pencil, or other instrument, proceeds to draw the sketch, or whatever it may be, of which an engraving is required, taking care to exert sufficient pressure to indent the tinfoil to the depth of the base plate, the intervening layer serving to give depth and tone to the lines, which may be made fine or coarse by using suitably pointed tools. In this manner letters may be written and sketches or drawings executed very rapidly and with great facility.

The next step is to place the prepared plate in a level position and pour over it a quantity of plaster of Paris, of which the matrix over which the stereotype or electrotype afterward to be made is formed. As soon as the plaster is sufficiently hardened or set the matrix is removed from the bed plate. This may be easily accomplished by slightly heating the under side of the plate, thus melting or softening the intervening layer, when the tinfoil, with its plaster backing, may be readily removed.

The face of the matrix (which is formed by the tinfoil) is now washed with benzine, turpentine, or other material, for the purpose of removing any portion of the intervening substance which may still adhere, and the matrix is now ready for stereotyping or electrotyping, which processes, being accomplished in the usual well-known manner, I deem it unnecessary to describe.

By drawing in the tinfoil with suitable tools, lines may be obtained as clear and sharp as the finest line engraving, the intervening layer serving not only to hold the foil upon the bed plate, but to give depth, tone, and richness. Its thickness may therefore be varied to suit circumstances.

To obtain correct likenesses of individuals, scenes from nature, etc., such likenesses are to be photographed upon the tinfoil, to serve as a guide for the draughtsman, whose task is thus reduced to a mere mechanical one.

By this process printing blocks of any subject may be produced with great rapidity and accuracy and at a trifling expense.

In lieu of tinfoil other equivalent material, such as gold foil may be employed.

Any suitable material may also be substituted for plaster of Paris for the purpose of backing the tinfoil or equivalent in forming the matrix.

THE IMPROVED HANSEN PROCESS.

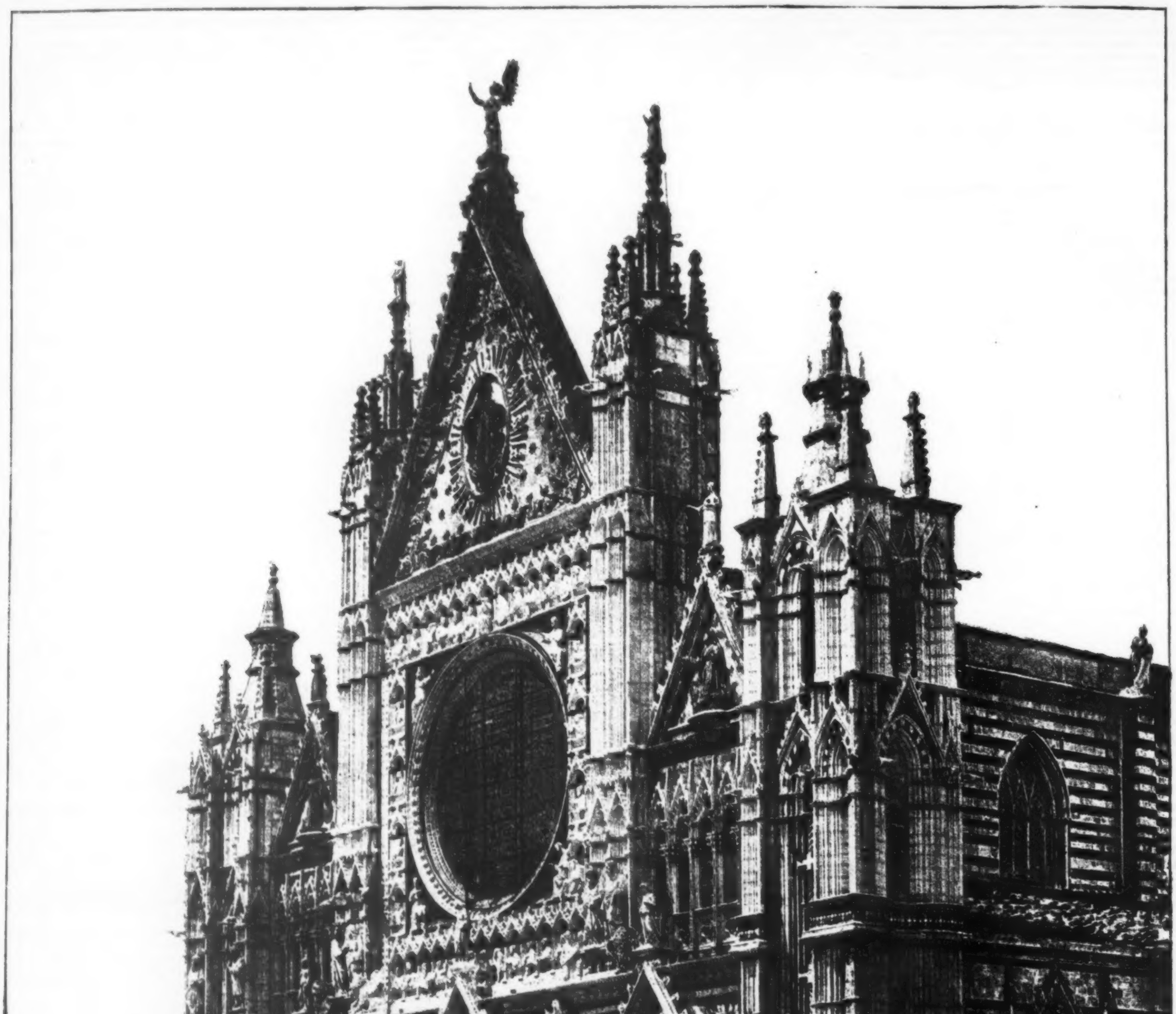
By Christian H. Hansen, Washington, D. C.

To carry out my process, I first provide a bed or base plate of steel or other suitable material that will resist heat, the top of which should be polished smooth and placed in a perfectly level position. Next, I provide the plate with a coating of plastic material which will resist heat—such as slaked lime, kaolin, tripoli, powdered cuttlefish bone, or other suitable material, which when mixed with a suitable quantity of water will form a plastic composition which may be spread evenly upon the top of the plate to form a coating of uniform thickness, and which will not melt or "run" by the application of heat.

The next step is to carefully cover the coating with a layer of any suitable foil which will not melt at the point of temperature where type metal melts. I have found that thin copper foil is well adapted for this purpose, and this should be provided with a thin film or coating of tin or solder. As thus prepared, the base plate is ready to receive the engraving by indenting the foil, down through the layer of plastic material, to the base by means of a stylus or other suitable instrument, according to the figure, sketch, or lettering which it is desired to represent in the engraving. The plastic layer operates to give depth and tone to the lines, which may be made fine or coarse by using different kinds of tools; and it will readily be seen that as the engraver has soft and yielding material to work in, the engraving, or rather indentation, may be executed with great rapidity. If desired, the sketch, figure, or lettering to be reproduced may be transferred upon the foil plate by photography, or other suitable means of transfer, to aid the operator in the execution of his work. The plate having been prepared in this manner, the thin film or coating of the foil is carefully moistened with muriatic acid, or other suitable acid, to prepare it to receive and firmly adhere to the type metal backing. The plate is placed in a suitable frame, after which a suitable quantity of molten type metal is poured over the foil to form a plate or backing of the desired thickness. The type metal, as it flows freely over the foil film, unites therewith without disturbing in the least the underlying foil or coating, and after hardening, the plate or relief block thus formed is removed from the coated base plate and is ready for use after washing its face to remove any trace of the coating material and suitably finishing the back.

Inasmuch as the object of the foil film is simply to cause the type metal to adhere to the indented foil, it is obvious that said film may be applied to the foil at any stage of the process prior to the pouring of the molten type metal upon the foil, and in any suitable manner; but on account of the simplicity attending its manufacture and use I prefer to employ copper foil which is provided with a thin film of tin or solder metal on one side.

THE herdic coaches in general use in many parts of this country, and especially in Washington, have just been introduced in London, and are proving popular as a substitute for the hansoms.



SIENA CATHEDRAL—THE GREAT FACADE BY GIOVANNI PISANO.

CHIMNEY CONSTRUCTION.

WE give from *Industries* a valuable table on the design and construction of chimneys. We add a few particulars concerning the new chimney of the Clark Thread Works, at Kearny, N. J., which is not mentioned in this table.

The Clark chimney is the highest in this country. Its external form is circular; height, 335 ft.; diameter at base, 28½ ft.; internal diameter, 11 ft.; total weight, 5,000 tons; cost, $30,000.

[illegible] Iron Co., 350'

THE DESIGN AND CONSTRUCTION OF CHIMNEY SHAFTS.

For whom constructed.	External form of shaft.	Total height, including foundations.	Height from ground line.	Outside dimensions of foundations.	Outside dimensions of shaft at ground line.	Outside dimension of shaft at top.	Inside dimension of flue at ground line.	Inside dimension of flue at top.	R'tio of h'ght to width externally, immediately above the footings.	Batter of shaft.	Weight of shaft.	Cost.	Maximum pressure per sq. ft. on brick work and foundations.	Thickness of brick work, and number of sections into which the shaft is divided.	Lining (internal).	Duty.
EXAMPLES OF EXISTING ROUND CHIMNEY SHAFTS.																
Mr Townsend, Chemical Works, Port Dundas, Glasgow. *a*	Circular (brick).	468'	454'	50' (circular).	32'	13' 4"	17' 10"	11'	14 to 1	1 in 48½	8000 tons.	£8,000	4·07 tons on foundation.	Twelve sections, 5' 7" thick at bottom, 1' 2" at top.	9" fire brick, with 9" air space, 60' in height.	Gases from chemical works.
Messrs. Tennant and Co., St. Rollox, Glasgow. *b*	Circular (brick)	455' 6"	435' 6"	50' (circular).	40' diameter.	13' 6" diam.	12'	11' 3"	11 to 1	1 in 32·9	4100 tons (about).	....	3 tons on top of concrete foundation.	5 sections, 2' 7½" thick at bottom, 1' 2" at top.	Inner lining, 203' high, 1' 10½" at base, 1' 2" at top.	....
Mechernich Lead Mining Co., near Cologne, Rhenish Prussia. *c*	Circular stalk on sq. pedestal, 32·8' high (brick).	441·48'	430'	39·36' (square).	32·8' (square).	11·48'	11·48'	9·84'	13·1 to 1	1 in 60½ (circular stalk).	5450 tons.	....	Base of stalk 0·961 tons, 3·7 tons on foundation.	27 sections, 11·48' thick in pedestal, 6·56' at base, 0·82' at top.	No lining.	Fumes from lead works.
Messrs. Johnson & Co., Cement W'ks, Greenhithe, Kent. *d*	Circular (brick).	304'	297'	30' (square).	25'	11'	17' 6"	8' 9"	11·9 to 1	1 in 41	2500 tons (about).	£2,500 (about).	9¼ tons (about).	Eight s'ct'ns, 3' 9" thick at bottom, to 1' 3" at top.	No lining.	Steam and fumes from cement kilns.
Dowlais Iron Works, South Wales. *e*	Circular stalk on sq. pedestal, 48' high (brick).	284' 5"	269' 8"	42' (square).	32' (square).	17' 8"	19'	15' 4"	8·5 to 1	1 in 38½ (circular stalk).	....	....	....	Eight sections, 7' thick in pedestal, 4' 6" at base of stalk, 1' 2" at top.	No lining.	Waste gases from boilers, &c.
Amoskeag Manufacturing Co., Manchester, New Hampshire, U.S.A. *f*	Circular (brick).	265'	255'	29' 8"	25'	12' 6"	19' 8"	10'	10·2 to 1	1 in 40·8	2330 tons.	£3,333	4·5 tons on foundation.	2' 8" thick at bottom, 1' 3" at top.	Lining 10' diameter throughout.	Fumes from 64 boilers=8400 h.p. Designed to burn 18,000lb. of anthracite per hour
West Cumberland Hematite Iron Works. *g*	Circular (brick).	267'	250'	34' 6" (square).	23' 7"	15' 3"	21' 10"	13'	8·75 to 1	1 in 49	2380 tons (about).	£1,560, or 4d. per cubic foot of the whole space occupied by the building.	At springing at flue arches 3 tons, 1·6 tons on foundation.	Four sections, 3' thick at bottom, 1' 10½" at ground line, 1' 2" at top.	Fire brick lining top to bottom. Upper 100' ½ brick thick, rest 1 brick.	Gases from four blast furnaces, stoves, & boilers. 10½ tons of fuel per hour.
Deptford Pumping Station, Metropolitan Main Drainage. *h*	Circular stalk on sq. pedestal, 30' high (brick).	160' to top of concrete bed.	150'	22' (square).	18' (square).	8' 3" diam.	7' 6"	6'	8·6 to 1	1 in 56½ (circular stalk).	....	....	....	4 sections, 5' 3" thick at ground line, 1' 10½" at base of stalk.	4½" fire brick lining carried up 30' above ground line.	Ten Cornish boilers, 30' long by 6' diam.
EXAMPLES OF EXISTING SQUARE CHIMNEY SHAFTS.																
*Messrs. Cox Brothers, Camperdown Linen Works, Lochee, Dundee. *i*	Ornamental (brick), square for 230', remainder octagonal.	295'	282'	35' (square).	30'	10' (octagonal).	14' 6" diam.	13' 8" diam.	9·5 to 1	Vertical sides with external offsets.	....	....	....	12' thick at foundation, 6' at ground line, 3' 3" 47' from ground line, 1' 6" at top.	Inner flue circular from top to bottom, 1' 6" thick at bottom, 9" at top.	58 furnaces, smiths' forges, &c.
*Messrs. Lister & Co., Manningham Mills, Bradford. *j*	Square ornamental (stone).	262' 6"	256' 6"	40' (square).	21'	21'	10'	13'	12·2 to 1	Vertical sides.	8000 tons (about).	£10,000 (about).	5 tons (about) on foundation.	....	9" fire brick 50' in height, 4" air cavity.	....
Crossness Pumping Station, Metropolitan Main Drainage. *k*	Ornamental (brick) stalk, with curve base on sq. pedestal.	227' to top of iron cap, 201' to bottom of iron cap.	162'	30' 2" by 28' 6"	26' 6"	12' below cap.	8' 3" diam.	8' 3" diam.	7·8 to 1	Curved batter for 42' high, remainder of st'lk v'tical	....	£4,000 (about).	....	5' thick at base of st'lk, 1' 10½" where curve ends, this thickness carried up throughout.	Fire brick lining carried up 40'.	Twelve Cornish boilers 6' diam. by 30' long.
Western Pumping Station, Metropolitan Main Drainage. *l*	Square (brick), no pedestal, orn'mental cast iron cap.	201' 9"	172' 9"	35' (square).	20' 9"	15' 2"	7' 3"	7'	8·4 to 1	1 in 69½	....	....	....	3' 5½" thick at ground line, 1' 2" at top.	Inner flue 14" thick from bottom to top, 4½" fire brick for 40'.	Eighteen Lancashire boilers, 22' long by 6' 6" diam.
Kent Brick and Tile Company, Pluckley. *m*	Square (brick).	....	170'	....	16' 6"	5' 6"	7' 6"	4' 6"	10·3 to 1	1 in 31	....	....	....	4½" thick throughout.	....	Gases from Hoffman's brick kilns.
Messrs. Stansfield and Co., Walham Green, London. *n*	Ornamental design, sq. st'lk on pedestal 32' 6" high (brick).	132'	120'	28' (square).	15' 6"	5' 6"	4' (square)	4' (square).	8 to 1	1 in 70 (sq. stalk).	....	£1,000 (about).	....	Five sections, 5' 7" thick in pedestal, 1' 10½" at base of stalk, 9" at top.	4½" fire brick lining 33' above ground line.	Two Lancashire boilers, two brewing coppers.
EXAMPLES OF EXISTING OCTAGONAL CHIMNEY SHAFTS.																
*Messrs. Wesenfield's Chemical Factory, Barmen, Prussia.	Octagonal stalk on sq. pedestal, 40' high (brick).	342'	331'	....	20'	11'	8'	8'	16·5 to 1	1 in 97	....	....	9¼ tons on lowest part of chimney.	5' 3" thick in pedestal, 3' 9" at base of octagon, 1' 6" at top.	....	Products from chemical factory.
*Messrs. Crossley and Sons, Dean Clough Mills, Halifax. *o*	Octagonal (stone).	330'	300'	32'	30'	15' 6"	9'	9'	10 to 1	1 in 41	8300 tons.	£9,000 to £10,000.	8 tons (about) on foundation.	....	Inner circular shaft of 14" fire brick, with a 3" air space.	Products from fifteen boilers, &c.
*Messrs. Storey Brothers, White Cross-street Mills, Lancaster. *p*	Octagonal (brick) stalk, with stone cap.	270'	250'	28' (square).	25'	10' 8"	8'	8' (octagonal): top 12', 9' 2".	10 to 1	1 in 54 (about).	3300 tons.	£2,800	4½ tons (about) on foundation.	Outer shaft 4' 6" at bottom, 1' 2" 20' from top, 9" at top.	Inner shaft 264' high, 18" thick at base, 9" at top, built parallel.	Products from boilers.
Abbey Mills Pumping Station, Metropolitan Main Drainage. *q*	Octagonal stalk on square (stone) pedestal 30' high.	212'	191' Ground line to top of stone cap, 158' 3".	37' 6" (square).	30' 6"	10' 3" (under side of stone cap).	8'	8'	....	1 in 100 for a height of 78' below cap.	Stone cap 60 tons, iron cap 27 tons.	Brick work in stalk cost about £8 per rod (labour only).	....	Three sections: (1) First 40', 4' 4½" to 1' 10½"; (2) 1' 6"; (3) 1' 2" thick.	....	Six Lancashire boilers, 8' diam., 40' long.

a Designed by Professor Rankine and R. Corbett. Largest shaft existing. *b* Designed by Professor Rankine and Messrs. Gordon & Hills. Second tallest shaft existing. *c* Third tallest shaft existing. *d* Designed by Mr. Johnson. *e* Designed by Mr. Martin. *f* Designed by Messrs. Stevens & Manning. *g* Designed by Professor Rankine. *h* Designed by Sir J. Bazalgette. *i* Designed by Mr. Maclaren. *j* Designed by Messrs. Andrews & Pepper. *k* Designed by Sir J. Bazalgette. Brick work in foundation and pedestal is built cellular. *l* Designed by Sir J. Bazalgette. Chief feature of this shaft is a stone spiral staircase, built in the space between the lining and outer shell. *m* Designed by Mr. Ward. Peculiarity of this shaft is that it is built of 4½in. cellular brick work. *n* Designed by Mr. Bradford. *o* Designed by Messrs. R. Ives & Sons. Chief feature, shaft entirely of stone. *p* Designed by Mr. Storey and Messrs. Paley & Austin. *q* Designed by Sir J. Bazalgette. Chief feature was cast iron cap, which has since been removed owing to chimney being much cracked. * Authority, Bancroft.

PHOSPHORUS IN IRON AND SLAG.

THE extent to which the hurtful influence of phosphorus makes itself felt in the wrought iron obtained by the Bessemer process is somewhat remarkable, because while two to three tenths per cent. is often present in puddled bars of fair quality, probably no consumer would accept Bessemer steel when it contains half of this amount. The first success was obtained in Sweden, where, by using pig iron containing a mere trace of the objectionable substance, a product was obtained which was satisfactory. For many years the beneficial effect produced by manganese on steel had been well known, and it occurred to R. F. Mushet, son of David Mushet, one of, if not the earliest scientific metallurgist in the United Kingdom, to try its influence in the converter on iron made from the hematite iron of the west of England, which contained from 0·05 to 0·1 per cent. of phosphorus. This addition, apparently by its removing occluded or combined oxygen in the molten iron, afforded the necessary relief, and the operation being one of extreme simplicity enables steel or wrought iron to be produced at a greatly reduced cost. To such an extent has this been carried that ore is brought by sea over a distance of 1,000 miles to Middlesbrough, and from it steel rails are made more cheaply than a greatly inferior article of iron can be produced from the abundant and economically wrought bed of ironstone found within a couple of miles of that town.

As an example of the facility of conversion may be adduced the fact that the molten metal is brought direct from the blast furnace, turned into steel or ingot iron as the case may be, and the heat evolved by the operation is sufficient to enable the product in many cases, without further use of fuel, to be taken direct to the mill and rolled into a finished bar.

We have just seen that 0·1 per cent., or thereabout, of phosphorus renders steel or ingot iron valueless; in like manner very insignificant variations in the quantities of carbon or silicon materially affect their quality. Now the blow, as it is termed, in a Bessemer converter may be accomplished in from twelve to fifteen minutes. It is clear, therefore, the opportunity of ascertaining the precise quality of the steel is one of very short duration. It is, I think, not disputed that a product can be obtained by this process possessed of very high, if indeed not of the highest excellence; but it is also pretended that the quality is not sufficiently uniform for certain purposes. The ordinary reverberatory furnace is incapable of affording the necessary temperature for melting steel or wrought iron, but by employing the fuel in a gaseous state, and by heating the air and gas before they are brought together, as it is done in the valuable furnace suggested by the Messrs. Siemens, the heat is so intensified that wrought iron in it is rapidly fused.

Steel is now largely made in such furnaces, either by mixing wrought and cast iron, as proposed by M. Pierre Martin, or by means of cast iron alone, when the carbon is removed by the addition of iron ore and some limestone, in which case, by the agency of the ore, the metalloids are oxidized and removed from the bath of iron. Some hours being required for this, sufficient opportunity is afforded for ascertaining the progress of the operation.

The cause of the iron in the Siemens furnace, as well as in the Bessemer converter, retaining its associated phosphorus in time began to attract the attention of chemists. In each case the expulsion of the metalloids is effected by oxidation. The carbon is gasified, and the silicium on being acidified is absorbed, and forms a slag containing usually 40 to 50 per cent. of silicic acid. In the presence of such an excess of this substance, any phosphoric acid, if formed, could not be absorbed by the slag.

It was the late M. Gruner, of Paris, who in 1867 first pointed out this fact, and he it was who first recommended the use of lime in order to render the slag basic instead of acid. Further, in order to avoid the presence of silica, he recommended at the same time that the converter should be lined with lime instead of with fire clay.

The same subject engaged my own attention, when guided by the fact that, as oxide of iron in the puddling furnace was capable of acidifying and removing a large quantity of the phosphorus as iron phosphate, it might be possible by keeping the temperature of the metal below that required for the process of puddling to make this removal more complete. The result of these experiments was communicated to the Iron and Steel Institute in March, 1877, when it was shown that pig iron containing 1·75 per cent. of P could in a few minutes have this reduced to 0·2 per cent.

This rapid destruction of the ordinary Bessemer converter led Mr. G. I. Snelus to consider the practicability of using a lime lining, and on experimenting with this on a working scale he confirmed the opinions previously enunciated by Gruner, by observing that the presence of lime had removed a considerable quantity of the phosphorus. These discoveries constitute the foundation of the very important basic process of Messrs. Thomas and Gilchrist, which consists in adding lime to the molten steel in a converter constructed on the principle described by Mr. Snelus. Considerable difficulty had, however, been experienced by this metallurgist in the attachment of the lime lining to the walls of the converter. This important question was solved by Mr. Edw. Riley by exposing dolomite to a very high temperature in order to prevent further shrinking, and then grinding and mixing the powder with coal tar. This formed a species of cement which is applied to the sides and bottom of the converter in the form of bricks or as cement.

The acidification and subsequent transference to the slag of the phosphorus by the basic treatment has led to its application to agriculture. For this purpose the slag is ground to a fine powder, and sprinkled over the land without any further preparation. By this operation an indispensable element of animal life is derived from the remains of living creatures which, ages ago, found a grave in the ferruginous mud destined to become the great Cleveland bed of ironstone.

SIR LOWTHIAN BELL.

British Association, Newcastle.

MIDDLESBOROUGH.

THE very old project of building railroads through Cumberland Gap, the corner to Kentucky, Virginia, and Tennessee, and developing the immense mineral and timber resources of that region, has at length been matured and accomplished through the efforts and with the capital of the American Association of London, England, and of the Louisville and Nashville R.R., of Kentucky.

The American Association was organized in 1887 for the purpose of buying lands in the United States; after having had examinations and reports made by experts, they decided to purchase the land at, and around, Cumberland Gap to the amount of 60,000 acres. This land, containing coal and iron, and being heavily timbered, lies in a compact body around the Gap in the States mentioned above, and embraces properties suitable for every class of commercial and industrial development.

The iron ore lies in the Cumberland Mountains and in the spurs of the same in Tennessee and Virginia, within an area of thirty miles long by one mile wide. The coal lies adjacent to the ores in the regular coal measures of southwestern Kentucky; in Log Mountain and its spurs surrounding Yellow Creek in Bell County. Besides iron ore and coal there are found also manganese, manganiferous ore, mineral paints, consisting of chromes, etc., limestone for fluxing purposes, sandstone for building, common clay and plastic and granulated fire clays, marbles, zinc, and lead; all in sufficient quantity to be profitably worked.

The timber consists of the choicest hard woods, and is easily reached by means of Powell and Clinch rivers and Yellow Creek. The L. & N. road has continued its Cumberland Valley branch from Pineville, a distance of eighteen miles, to the Gap, connecting there with the Knoxville, Cumberland Gap, and Louisville road from Knoxville. This last named road passes through the Cumberland Mountains by means of a tunnel directly under the Gap. In addition to these roads, one from Big Stone Gap, in Virginia, is now being constructed, and will be completed within the next six months, thus giving a route through Virginia to the sea coast.

On the Kentucky side of the Gap the town of Mid-

dlesborough has sprung into existence; where there was not a building six months ago there is now a town of 1,500 inhabitants, with a reasonable certainty of growing to 10,000 within the next six months or year.

The cause of the sudden appearance of a town at this heretofore neglected site is the advantages opened to manufacturers. Fuel is cheap and close at hand; raw material is easily obtained in any quantity; shipping facilities are unrivaled; and there is a market close at hand. Already there are in operation, or about operating, coal mining companies and furnace companies, with an aggregate capital of two and a half million dollars; five companies engaged in the manufacture of brick—the clay being excellent—with a capital of one hundred and sixty-five thousand dollars; six saw mills having invested one hundred and ninety thousand dollars; machine shops with ten thousand dollars; sash and door factory with five thousand dollars; and a belt railroad contemplated, with branches to all of the larger manufactories. Besides the enterprises mentioned above, there are a number of smaller ones operating on from one to five thousand dollars, and employing from five to ten mechanics. In addition to the foregoing, there are a number of coke ovens; and an iron and steel company projected; also a spoke and handle factory. It will be seen that Middlesborough is not a "mushroom town," but has an assured future.

As a further evidence of this, it should be noted that there are in course of erection water works sufficient to supply the town; a gas plant; an electric light plant; an ice manufactory; an electric street railway; horse car railway; one of the largest tanneries in the world; an opera house projected; a town hall; six churches; a large school building; two hotels, to cost one hundred and twenty five thousand dollars; a union depot; three banks; a newspaper office (*The Cumberland Gap*) to cost ten thousand dollars; and telephone and telegraph offices.

In addition to the L & N. R.R., the K.C.G. & L. R.R., and the road from Big Stone Gap, there are twelve other roads being projected. This is not surprising when it is remembered that from the Breaks of the Sandy, in the north, to Bull Finch Gap, many miles south, the Cumberland Gap is the only point at which the Cumberland Mountains can be crossed. Here the tunnel built by the American Association, at a cost of two hundred and fifty thousand dollars, gives the only possible means of getting across this chain of mountains. That the Gap is readily reached from any direction is another point in its favor.

Across the mountain from Middlesborough, in Tennessee, is the town of Dillwyn Springs, where Eastern capitalists intend making a national sanitarium. It is peculiarly suited for such a purpose, being now of easy access, having a fine and equable climate, being in the midst of magnificent scenery, and being near eighteen mineral springs, from which water of nearly any character can be selected. Already a large and commodious hotel has been erected at that point.

Middlesborough will celebrate the beginning of her existence in October, when, from the 14th to the 19th, the railroads will give reduced rates, and all visitors will be given a Kentucky welcome. It is worth any one's while to make the trip, if for no other purpose than to see what is being accomplished in the "New South."

THE NEW GERMAN RIFLED MORTARS.

IN order to realize the progress that has been made in the last thirty years in artillery *materiel*, it is only necessary to compare the antique block of bronze which constituted the smooth-bore mortar with that piece of ordnance which was erected but yesterday—the rifled mortar. Every one will remember the smooth 12½ in. mortar, stumpy and resting squat upon its bed, that threw huge sperical bombs upon a parabolic trajectory with so little precision that it was a miracle when these projectiles reached the mark. Accident seemed to such a degree the preponderant factor in indirect fire that Carnot, pushing on to paradoxy, chose to make it the rule thereof, and recommended the firing of a large number of bombs in broadcast volleys and without pointing, because probability seemed to him still the best artillerist with a piece of ordnance defying all precision.

It is therefore not surprising that pieces with curved fire were so little used, and constituted merely a complement of siege artillery that was, it is true, indispensable, since it was very necessary to try to reach the enemy and his *materiel* behind shields and accumulated obstacles; but it was quite inefficient.

However, the necessity became still the more pressing of giving indirect firing the efficacy that it lacked, in that it was becoming more the habit to sink down and disappear in order to escape the more and more formidable effects of a direct shot. A beginning was made by firing ordinary rifled ordnance with reduced charges, in order to obtain a trajectory of less curve and grazing the crest of the obstacles; but, in order to burn these small charges, it was no longer necessary to have so long a gun, and hence the origination of types of short guns analogous to the old howitzers.

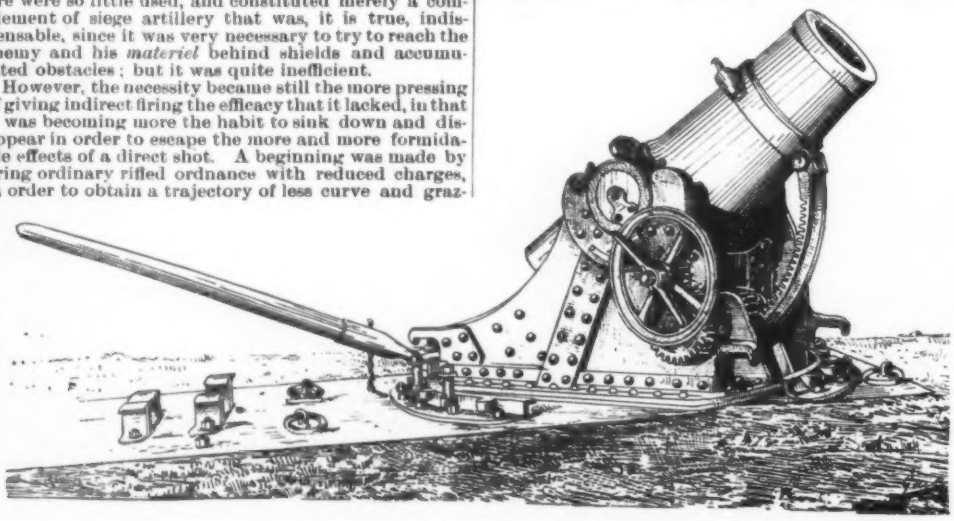


FIG. 2.—THE MORTAR IN ITS POSITION FOR FIRING.

These short guns were to lead to rifled mortars designed solely for firing with very reduced charges and at wide angles. Nevertheless, these mortars would never have been able to produce powerful effects had it not been for the introduction of a new projectile endowed with remarkably destructive qualities—we refer to the torpedo shell.

The live force with which the projectiles of this kind reach the obstacle is no longer the principal factor of their power; it is the explosive charge that they may contain from which the whole effect is expected. The bomb of former times has given way to huge elongated projectiles of from five to six times their caliber, containing, for example, for the German 8 in., 48½ lb. of gun cotton, and for the French 8¼ in., 73 lb. of melinite.

It is this terrible mine chamber that it is a question of bringing into contact with the obstacle to be crushed, and the effects of the explosion are such as could not be produced by means of the projectiles commonly used in a direct fire, notwithstanding their immense live force. The result is that the use of rifled mortars is becoming commoner and commoner in the attacks on fortifications, and that such weapons must now enter in large proportions into the composition of siege equipages. As their useful effect depends especially upon the quantity of explosive material carried by the projectile, it is evident that small calibers are not very advantageous for pieces with curved fire. So, although there exist rifled mortars of reduced caliber, it is especially with calibers of over 7¾ inches that we find really powerful pieces.

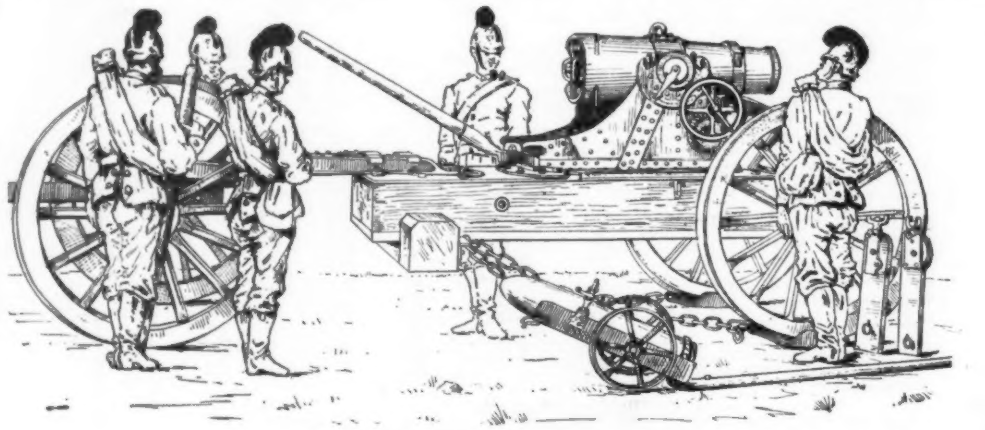


FIG. 1.—THE NEW GERMAN RIFLED MORTAR.

The following is the composition of the siege equipages of the German army. The artillery comprises no less than 1,352 pieces of ordnance, thus distributed: 1. 5 large equipages, each comprising 4 identical sections of 60 pieces, say 1,200 in all; 2. 2 special equipages, each of forty pieces, say 80 in all; 3. 3 complementary sections, each formed of 24 pieces—say 72 in all.

Each section of the large equipage has the following composition:

Guns.	Rifled Mortars.
24 heavy 4·6 inch	6 8 inch.
12 short 5·8 "	6 6·25 "
6 hooped 5·8 "	6 3·5 "

The special equipages comprise each of them:

12 4·6 in. guns.
20 short 7·8 " "
8 rifled 8 " mortars.

These latter equipages respond to a tactical need which will doubtless make itself felt as pressingly with us, and which results from the different roles that Germany and France would have to hold in another war.

The treaty of Frankfort had hardly been signed, when the Germans prepared everything for a new agression. While opposite Metz and Strasbourg we were constructing two forts, like two advance guards to bar their route, they, on their part, were preparing everything that was necessary to force this barrier, and, by making a sudden irruption, to throw disorder into the concentration of our army. It was for this purpose that the two special equipages, of which an extreme mobility was required before all else, were assembled at Metz and Strasbourg.

The German parks were composed of an equal number of long guns and pieces with curved fire; on the contrary, the special equipages designed for the attack of our forts were almost exclusively composed of the latter kind of weapons, which, alone, are adapted for a sudden attack and a vigorous bombardment.

In order to accelerate, to as great a degree as possible, the placing in battery, the German mortars are carried all mounted upon their platform (Fig. 1). To this effect, the front part of the system is provided with hoops into which may be fitted the journals of a pair of axles. At the other extremity of the platform, a false pole made of iron is fixed in two lugs, and is attached to a limber. It is only necessary to place the piece and its platform directly upon the ground, to have it immediately ready for firing (Fig. 2).

On account of the wide angles at which these mortars are required to fire, it has been possible to fix their carriage to the platform by a solid pivot around which it can revolve without recoil. The base of the cheeks moves upon two semicircular tracks concentric with the pivot and situated in front and behind. The movement of the carriage upon these permits of pointing in any direction, and is effected through a chain apparatus like that of the Krupp system of stronghold chassis. The rotary motion is controlled by an inclined shaft actuated by means of a winch. For pointing in elevation, the mortar is provided in front with a toothed arc actuated by a gearing affixed to the cheeks of the carriage and set in motion by a hand wheel.

It may have been remarked in the composition of the equipages as given above that the normal and regular service does not include pieces of a caliber greater than 8 inches.

The German artillery, however, has recently had added to it a rifled 9·4 inch mortar, which was tested at the Meppen polygon in August and September, 1884. In the construction of this new piece, considerable improvement has been made upon the rifled 8 inch mortar, especially in respect of lightness—a subject that seems to be preponderant in the minds of artillerists beyond the Rhine.

The following table, which we borrow from the *Revue d'Artillerie*, permits of a comparison of the two pieces of ordnance from the standpoint of mobility:

	8 in. mortar.	9 inch Krupp mortar.
Caliber....................	8 in.	9·4 in.
Total length..................	59 "	79·5 "
Weight with closing device..	6,655 lb.	3,740 lb.
" of " " ..	495 "	447 "
" " carriage.........	4,345 "	3,540 "
" " platform........	4,345 "	7,520 "
" " limber.....	6,897 "	5,764 "
" total, of equipage....	13,552 "	9,614 "
" platform converted into carriage.......... ...	13,552 "	9,768 "

The length of the 8 inch piece, in calibers, is 7·2, and of the new 9·4 inch Krupp mortar, 8·5.

Despite its great power and its much greater length, the weight of the piece is lessened by 43 per cent., and that of the entire system by 31 per cent. The length of the 9·4 inch mortar is 6·7 feet. The diameter of the powder chamber is 9·6 inches, and that of the projectile chamber, 9·4 inches. The grooves are 23 in number, and are 0·06 of an inch in depth and 1 inch in width and have a pitch of 15 calibers.


FIG. 3.—PROJECTILE OF THE NEW 9·4 INCH GERMAN MORTAR.

The 8 inch mortar throws a 174 lb. projectile with an

initial velocity of 700 feet per second, with a maximum charge of 7¼ lb. of powder.

The Krupp 9 4 inch mortar throws a 300 lb. projectile with a velocity of 682 ft. The charge employed is 12 lb. of coarse-grained powder.

The cheeks are of double boiler plate. The platform consists of a flooring of longitudinal oak joists of 11¾ inches section, covered above with ½ inch iron plate, and beneath with thinner plate and transverse madriers. The platform is 10 ft. in length, 5½ ft. in width, and 17 inches in thickness.

The pivot of the carriage is situated at a distance of 4 feet from the front edge. The circular tracks have a radius of 33 inches. They are fixed, as is also the pivot plate, with bolts that traverse the joists, and the nuts of which press against a counter plate set into the bottom of the platform.

The piece embraces a 40° horizontal field of fire with a maximum charge, and one of 60° with other charges. The maximum angle of fire in a vertical plane is likewise 60°.

When the piece is in battery, the axis of the trunnions is 29 inches above the platform. The carriage is provided with a wide iron plate hinged step.

In order to load the piece, the projectile is put upon a carriage which is made to ascend an inclined plane so as to land it upon the step.

Such are the general arrangements of these weapons, whose characteristic, it cannot be too often repeated, is mobility.

They are designed to be drawn behind armies in the field and to sustain a certain offensive by immediately breaking down the obstacles that seem to be opposed to their progress at the beginning of hostilities.

The circumstances of war under which the French armies will be placed will doubtless be entirely different, and it would be wrong to compare the similar pieces of the artillery of the two countries without taking into account the necessities of this situation.

With us, the endeavor has been to construct powerful pieces that should be irreproachable from the standpoint of ballistics. In this we have succeeded, and our rifled 8½ and 10½ mortars certainly give a more efficacious fire than the German 8 and 9·4 inch ones.—*Le Genie Civil.*

COMPRESSIBILITY OF THE GASES OXYGEN, HYDROGEN, NITROGEN, AND AIR UP TO THE PRESSURE OF THREE THOUSAND ATMOSPHERES.

By E. H. Amgat, in *Comptes Rendus*, and translated by Chief Engineer Isherwood, U.S.N., for *Journal of Franklin Institute.*

The experiments on these gases were made according to the method I followed in my previous investigations of the compressibility of liquids within the same limits of pressure; but, in the present case, the difficulty was much greater, owing to the smallness of the volume of the gases when strongly compressed. Nevertheless, after numerous trials, I obtained perfectly regular and concordant results by employing, for the gauging of the platinum wire tubes, the same process of reading by electrical contacts which served afterward to estimate in the same tubes the successive volumes of the compressed gases. In this manner I obtained for the same gas, with different tubes, graphic curves which almost absolutely coincided with each other.

My results, given further on (and they are solely the apparent results), differ notably numerically from those obtained by Natterer. The differences within the limits common to our researches are very irregularly distributed, and amount to several hundreds of atmospheres. My experiments for the same reduction of the volume of the gas give in general much greater pressures than his, but the differences can easily be accounted for by the probable and even inevitable causes of error in the method followed by him.

The following results relate solely to great pressures; the pressures below 1,000 atmospheres will be investigated in part by means of an apparatus permitting the use of temperatures vastly higher than I have been able to command with the apparatus imposed by the very great pressures, and with which I have been able to operate between only 0° C. and 50° C.

The following table gives for the pressures, in the first column, the volumes of the gaseous mass at 15° C. relatively to its volume as unity at the same temperature and under the pressure of one atmosphere:

Pressure in Atmospheres.	Air.	Nitrogen.	Oxygen.	Hydrogen.
750.	0·002200	0·002262	....	....
1,000.	0·001974	0·002032	0·001735	0·001688
1,500.	0·001709	0·001763	0·001492	0·001344
2,000.	0·001566	0·001613	0·001373	0·001161
2,500.	0·001469	0 001515	0·001294	0 001047
3,000.	0·001401	0·001456	0·001235	0·000964

The comparison of the compressibility of strongly compressed gases with each other, and with that of the liquids, is interesting, and to facilitate it I have calculated for differences of 500 atmospheres of pressure the coefficients of compressibility of the gases, as habitually defined for liquids. In the following table are the results obtained:

Pressures in Atmospheres.	Air.	Nitrogen.	Oxygen.	Hydrogen.
Betw'n 750 and 1,000	0·000411	0·000407	....	....
" 1,000 " 1,500	0·000268	0·000265	0·000258	0·000408
" 1,500 " 2,000	0·000167	0·000170	0·000160	0·000272
" 2,000 " 2,500	0·000123	0 000122	0·000115	0 000197
" 2,500 " 3,000	0·000093	0·000091	0·000091	0·000158

We see that, under very great pressures, the gases oxygen, nitrogen, and air have nearly the same compressibility, and that it is of the order of magnitude of the compressibility of the liquids: at 3,000 atmospheres it is sensibly equal to that of alcohol under normal pressure.

The compressibility of hydrogen is very much greater—nearly double—and at 3,000 atmospheres it is almost equal to that of ether under normal pressure.

There may be easily foreseen that these compressibilities should, as in the case of liquids, increase with the temperature, which is shown, as regards hydrogen, by the following table:

Limits of Pressure in Atmospheres.	Coefficients.		
	At Zero.	At 15·4°	At 47·3°
Between 1,000 and 1,500	0·000	0·000408	0·000416
" 1,500 " 2,000	0·000263	0·000272	0·000280
" 2,000 " 2,500	0·000196	0·000197	0·000208
" 2,500 " 3,000	0 000156	0·000158	0·000.58

The apparent densities are easily deduced from the first table; and admitting, provisionally, for the compressibility of gas the number generally adopted, we obtain the following results for the pressure of 3,000 atmospheres:

DENSITIES OF THE GASES UNDER THE PRESSURE OF THREE THOUSAND ATMOSPHERES, RELATIVELY TO WATER.

	Apparent.	Real.
Oxygen	1 0972	1·1054
Air	0·8752	0·8817
Nitrogen	0·8231	0·8293
Hydrogen	0·0880	0·8887

The curves obtained by laying off the pressures as abscissæ on an axis, and the products, $p\,v$, as corresponding ordinates perpendicular to the axis, are nearly straight lines, but they all have a slight concavity toward the axis. I shall return to this important point as regards the limited volumes after I shall have determined the variation of the volume of the envelopes.

THE BENDEGO METEORITE.

In 1784, Joaquim da Motta Botelho informed the governor-general of Bahia that upon a hill near the brook of Bendego there was a colossal stone which, in his opinion, contained gold and silver. The following year, Benardo Carvalho da Cunha, captain-major of Itapicura, was solicited by the governor-general to do his best to have the stone conveyed to the nearest seaport, so that it might be shipped to the capital of the province. Accordingly Carvalho caused a large wooden ox-cart to be constructed, and, undeterred by the cost, had a stone roadway laid for the crossing of the brook. After innumerable difficulties, successfully overcome, the mass was started upon its journey, drawn by twelve pairs of oxen. All went well for a distance of about six hundred feet, when, on descending a hill, the speed of the cart became accelerated. The axles caught fire, and the vehicle and its load ran into the Bendego. Nothing further was thought about the matter till 1810, when A. F. Mornay, who had been commissioned by the governor-general of Bahia to study the mineral resources of the interior of the province, hearing of the existence of this extraordinary stone of gold and silver, decided to go and see it.

Accompanied by its discoverer, Botelho, he went to the Bendego the same year, and there found the stone still upon the cart. An examination of it showed him at once that it was a meteorite composed of metallic iron. With some difficulty, he secured a fragment weighing a few pounds and sent it, with an interesting note, to Dr. Wollaston, secretary of the Royal Society of London.

Mornay's note was read to the society on the 16th of May, 1816, with a note of Dr. Wollaston, and inserted in the same year in the *Philosophical Transactions.*

The dimensions of the meteorite as given by Mornay were as follows:

Length, 7 feet; extreme width, 4 feet; extreme thickness, 2 feet. He estimated the mass at 28 cubic feet, and the weight at 14,000 pounds.

Dr. Wollaston's analysis gave as the composition:

Iron	95·1 per cent.
Nickel	3·9 " "
Various substances	1·0 " "

In 1811, the meteorite was examined by Brigadier Felisberto Caldeira, who made a new attempt to convey it to the capital.

In 1820, the naturalists Spix and Martius visited the locality and found the meteorite deeply buried. They succeeded, with great difficulty, in detaching a few specimens from the block, which eventually went to enrich the collections of Europe.

From that period, the meteorite lay forgotten in the interior of Bahia until 1883, when Prof. O. A. Derby, director of the geological section of the national museum of Rio de Janeiro, fearing that it might have become covered with alluvium, asked Engineer Sampaio to obtain some information concerning it. On receipt of the desired information, Prof. Derby laid the matter before Counselor Netto, director of the national museum, who, desiring further data in regard to this scientific rarity, had Engineer Vincente Jose de Carvalho sent in 1886 on an exploring trip to find the meteorite and to see by what means it would be possible to remove it to the museum. Carvalho's report was read to the Rio de Janeiro Geographical Society on the 3d of June, 1887. On this same day, the society unanimously resolved that it would take upon itself the removal of the meteorite to the capital in order to present it to the national museum. At this juncture, Baron de Guahy, deputy of the province of Bahia, came forward and offered to defray all expenses of carriage, estimated at $10,000, while the minister and secretary of state of agricultural affairs expressed his readiness to aid the society with all the means in his power.

With such resources, all difficulties gave way. On the 25th of November, 1887, the meteorite was placed upon a cart drawn now by oxen and now by men, and, on the 14th of May, 1888, reached Jacuriey, a station on the railway from Bahia to San Francisco. On the 15th, the mass was placed upon a car, which, on the 22d, landed it at Bahia, whence it was shipped by ocean to Rio de Janeiro. The whole undertaking was a most difficult one, and the success with which it was carried out reflects great credit upon those who had it in charge.

The Brazilian government has celebrated the event by the erection of two obelisks and by the publication of a quarto volume * illustrated with photographs, a colored plate, several figures in the text, and a large geographical map, with a section giving the details of the itinerary on a scale of $\frac{1}{100000}$. In addition to the report made by Mr. Carvalho, the volume contains a very interesting paper upon meteorites in general, from the pen of Mr. Cruls, director of the Rio de Janeiro observatory.

THE HISTORY OF THE GREAT AMERICAN LAKES. †

By Prof. J. S. Newberry.

In this paper Professor Newberry gave a *resume* of his observations during the last twenty-five years on the structure and the history of the basin of the great lakes. This history is briefly as follows:

At the close of the carboniferous age all that part of the continent of North America lying between the Mississippi and the Atlantic was raised out of the ocean and has remained a land area to the present time. The sea has risen and fallen on its shores, leaving there the sediments which accumulated when the water stood high, and remain as the cretaceous and tertiary margin of the highland. At other times the sea level was many hundred feet lower than now. Then the Ottawa, the Hudson, the Delaware, the Potomac, and James rivers ran down with swift currents to the ocean, excavating deep valleys which now in another subsidence are filled with backwater and have become the tideways by which the coast is fringed. By the elevation of the Alleghanies a valley was formed between them and the Canadian and Adirondack highlands. This valley was drained by a great river now represented by the St. Mary, Detroit, Niagara and St. Lawrence, but during most of its existence it flowed to the ocean by way of New York, and as we know by its now submerged trough, its mouth was 80 miles south and east of New York harbor. For countless ages this river carried off the surplus water of a great drainage area, and as the continent was high and its current rapid it cut down its bed in a continuous gorge many hundred feet in depth, reaching from the basin of Lake Superior to the narrows below New York, where it flowed out on to a broad littoral plain.

Between the Adirondacks and the Helderberg mountains this great river, which had no name and no human eyes beheld, cut a barrier, the principal impediment to its progress, and formed a water gap that in its influence on human history is the most important topographical feature on the continent; for this is the great gate through which the tide of humanity flowed from the coast to the interior, and where the most important canal and railroad lines in the world have been laid.

Up to the close of the tertiary age our great lakes had no existence. Then came the Ice Period, when the whole aspects of nature were revolutionized. Over more than half the continent snow fields took the place of the luxuriant forests which had before reached to the Arctic Ocean, and glaciers extended southward to New York, Cincinnati, and St. Louis. As the cold increased, local glaciers were formed on the southern slope of the Canadian highlands. These gradually extended down the tributaries of the great river before described, ultimately occupying and greatly modifying its valley, locally scooping out great basins by a kind of erosion which is characteristic of ice, but never produced by water.

Finally, the great valley was filled with ice, that overtopped its southern margin in Ohio and Indiana, and reached high up on to the Alleghanies in Pennsylvania. For untold centuries the ice, sometimes thousands of feet in thickness, moved on, planing off or rounding over all eminences, filling pre existing gorges with debris, and completely remodeling the topography.

When the climate became milder, the great ice sheet retreated, leaving a coating of moranic material over a million of square miles, where it averages not less than 50 feet in thickness. This filled and obliterated a large number of pre-existent river valleys, some of which are being re-excavated by the draining streams; in other cases they have abandoned their ancient valleys and have found lines of lower level elsewhere. The changes made in the valley of our great river were most important. In places deep and broad rock basins had been excavated, in other places its channel had been so filled with drift material that it was compelled to choose new routes. The basins partly excavated by water and ice, partly the result of damming, are our great lakes, and the new channels are those of the rivers St. Mary, the Niagara, and the St. Lawrence.

A bank of drift on the south shore of Lake Superior, east of the Pictured rocks, turned the flow of water over the rocky barrier at the east end of the lake, and formed the falls of St. Mary. A similar bank of drift obliterated the channel between Lake Erie and Lake Ontario and turned the water over the Lewiston ridge, and formed the cataract of Niagara. A still more important change was made by the filling up of the old valley of the Mohawk, by which the river was compelled to find a new outlet from the northeast corner of Lake Ontario through the rocky and shallow channel of the St. Lawrence.

No one has ever reached the rocky bottom of the Mohawk Valley, but the drift material which occupies it has been penetrated far below the ocean level. The rocky ledge over which the Mohawk pours at Little Falls has been cited as proof that the great river never flowed through this valley; but this is a case similar to that of the Niagara, the St. Mary's, and the Ohio at the Falls. The ancient channel is near, but so completely filled that the water has been deflected over a

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* Rapport presente au Ministere de l'Agriculture, du Commerce et des Travaux publics, et a la Societe de Geographie de Rio de Janeiro sur le Deplacement et le Transport du Meteorite de Bendego de l'Interieur de la Province de Bahia au Musee National. Par Jose Carlos de Carvalho. Rio de Janeiro: Imprimerie Nationale, 1888.

† Abstract of a paper read at the meeting of the American Association for the Advancement of Science, Toronto, Ont., Aug., 1889.

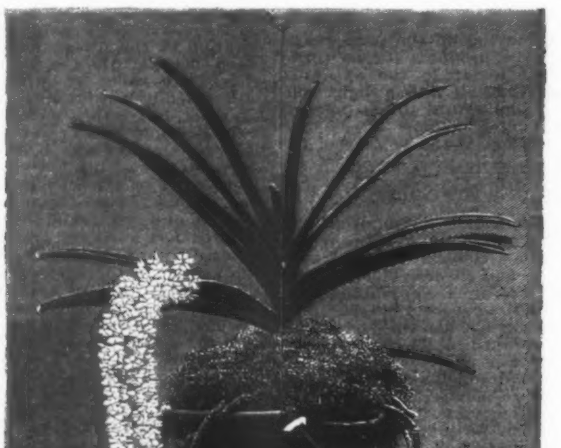
spur of rock projecting from the south side of the valley. The evidence cannot all be given here, but it is such as must convince every intelligent man that there was once a continuous line of drainage from the highlands north of Lake Superior to the ocean near New York, and that the changes that were made by the Ice Period in the valley of the great river which flowed along this channel have given us our chain of great lakes.—*Eng. and Min. Jour.*

SACCOLABIUMS.

By W. H. Gower.

There is an exquisite grace and charming elegance in the saccolabium, as the illustration before us shows. It cannot be denied but that these plants do require more warmth than the majority of orchids, but still not more than crotons, dipladenias, or such like plants, and why cannot saccolabiums be found a place beside them? They do not like so much sun as is requisite for a croton, and they do not require quite so much syringing as a dipladenia; but there are plenty of intermediate places in the same house which would suit them if one cannot devote a house to the growth of orchids. In the winter months I used in years gone by to keep the saccolabiums in a temperature of 60 degrees, which rose by fire heat during the day about 5 degrees, and when the sun was strong I did not mind if it went up a few degrees higher. The plants were kept comparatively dry—indeed, their foliage was never wetted—but there was sufficient moisture kept about the roots to prevent the leaves from shriveling. I do not like to see an orchid shriveled, because I contend that a plant can be bloomed more freely and retain its foliage in a better manner by lowering the temperature than by drying it up and causing the leaves to shrivel. It is true these plants do lose a leaf occasionally, but at rare intervals if properly attended to, for as they have no pseudo-bulbs to sustain them through a long period of drought, they must be carefully nursed. I here append the descriptions of a few kinds which are well deserving the attention of all growers of orchids:

S. Blumei and its variety *majus*, of which latter we here give an illustration, and which may be taken as the general appearance of all the species, although some have longer and more recurved leaves. There are others whose leaves are shorter and which have erect spikes of flowers, but this latter section will be omitted in these notes. Like all the other kinds here referred to, *S. Blumei majus* should be grown with good exposure to sun and light, shading it, however, from the hottest sun. Good exposure to sun and light is necessary to ripen up the growth, and thus enable it to pass through the winter well, and to flower in due season. *S. Blumei* and *Blumei majus* do not differ so much in color, but the last named plant produces a denser and much longer raceme of flowers, the sepals and petals being white, or creamy white, suffused with a tinge of rose, and dotted with magenta, the lip a bright rosy purple or magenta rose, while the flowers are gratefully perfumed. In this variety the spike is upward of two feet in length, and it will last in perfection about three weeks. It blooms at the present season, and frequently continues to flower until the middle of October. It is a native of Java, Luzon, Moulmein, and other islands in the Indian seas. There is a pure white form of this plant, which is, I believe, at present unique.—*The Garden.*



SACCOLABIUM BLUMEI MAJUS.

The Telephone in Switzerland.—The cheapness of the telephone service in Switzerland has led to its general adoption, the annual cost being about $25 a year. The government has charge of the telephone service, which is under the control of the Department of Posts and Telegraphs.

[Garden and Forest.]

OLD MISSION SAN JOSE GARDENS.

California has but few old gardens, although the Bidwell grounds at Chico, the Fox nurseries at San Jose, and some of the old Oakland and Sacramento homesteads date back to the early fifties. Still older, belonging to a different regime, are the old mission gardens of the last century. Some of these are still kept up; others have fallen into decay, but all are full of a tropical beauty of their own, because the palm, olive, and the vine so much predominate. One old estate, within thirty-five miles of San Francisco, combines in a remarkable degree the charm of the Spanish gardens of the eighteenth century and the charm of the early American gardens. I refer to the Gallegos grounds, near the Mission San Jose, planted chiefly by the Beards and Elsworths, thirty and forty years ago.

The estate of Juan Gallegos includes six hundred and forty acres of vineyard, besides large orchards and extensive pastures. The twenty acres or so that immediately surround the old mansion show as fine a lawn and landscape of native trees as can be found in California. Besides this, there are some trees which were planted by the Mission padres, old pears and olives of sixty years' growth. There are avenues of figs and groves of olives and oranges, all large trees in full bearing. There are many palms, large pines, and choice specimens of deciduous trees. On the hill slopes, east of the plateau, at the base of Mission Peak, where the home grounds are situated, is an old avenue of Spanish-planted trees, pears and olives of nearly a century's growth, which rank among the finest relics of mission gardens left in California.

E. L. Beard, a man of great ability and energy, began farming in Santa Clara Valley at this old Mission in the days of 1849-50. He established a nursery here in 1852, sending an agent to the Atlantic States for seeds, scions, and young trees, which were taken to California by the way of Panama. In 1853 the ordinary price of a one-year-old cherry, peach, or pear tree was five dollars, and those who bought, and set out orchards, found that, in 1857 and 1858, the fruit brought twenty-five cents and more per pound.

Mr. Beard and his stepson, Henry Elsworth, developed an orchard and wheat farm which extended over an area of two thousand or more acres, in and about the Mission San Jose. Their homestead tract, where plantings of ornamental trees began early in the fifties, was the tract that is now the heart of the Gallegos estate. We have seldom had farmers on the Pacific coast who showed the intense love of beautiful trees that Mr. Beard always did. His groves were on rich, well-watered, and sunny slopes. To these he brought specimens of nearly all the native conifers of California and of many of our finest deciduous trees and ornamental shrubs. His Eastern connections enabled him to secure, and he planted here, all the spruces, firs and pines to be had in Eastern nurseries. He also had Australian and Japanese correspondents many years ago, and planted acacias, Japanese persimmons, and other imported trees, ten years before any one else had them. He planted a great many olives and oranges in groves and avenues; large fig groves and many palms, chestnuts, walnuts, and other nut-bearing trees were grouped near bridges across the stream, and behind his residence were large fruit orchards and vineyards stretching down the valley.

At present, after more than thirty years of uninterrupted growth, under most favorable conditions, the trees that surround the lawns and "opens" of the place are notable for size and beauty, even in California, and they attract many visitors. Mr. Juan Gallegos, the present owner, is a wealthy Spanish gentleman from Costa Rica, educated in England, and now one of the largest and best known of viticulturists in the State. He has greatly extended the ornamental grounds, and especially delights in plantations of palms of various sorts, particularly the date palm, so that the estate is becoming more and more tropical in its appearance. He is passionately devoted to the old trees, planted by his predecessors, and to the still older pear and olive trees planted by the Spanish padres. The orange groves are now in heavy bearing condition; the olives begin to yield well, and the vineyards are so extensive that he has sometimes carried a stock of one million gallons of wine in his cellars.

An interesting fact in reference to the olive in this region deserves record. The trees of the old avenue of which I have spoken are of the Mission variety, so called, the kind brought to this coast by the padres, and variously identified since with sorts still cultivated in Spain. The trees planted by the padres here, however, differ much in growth, and are probably seedlings of the Mission variety. Some ripen early, others are very late, and some are much better bearers than others. The old pear trees were of two sorts, a small, early pear of russet color, ripening about with the Madeleine, and a large, bronze-colored, late, coarse pear. The grapes were all of the old Mission sort, the same grape that grows to-day in the vineyards of the lower Rio Grande, and is so famous in the southwest as the "El Paso grape." I am told by an old pioneer who knew the Mission San Jose before the conquest of California, that the quaint old Spanish garden contained in its exact center a seedling apricot tree, which was an object of superstitious fear to the Indian neophytes, for they were taught that its fruit was the fruit of "The Forbidden Tree." They always went by it with bowed heads and crossing themselves. On three sides of the old garden towered an immense wall of *Nopal* or Mexican prickly pear, with adobe buildings, walls, and the church on the other side.

Charles Howard Shinn.

Niles, Cal.

ODORIFEROUS GRASSES OF INDIA AND CEYLON.

At a recent meeting of the Natural History Society of Bombay, Mrs. J. C. Lisboa read a paper on this subject. Mrs. Lisboa gave interesting notes on the six known species of *Andropogon* which grow in India and Ceylon, and the most important of which, from a commercial point of view, are *A. nardus*, Linn. (the source of citronella oil), *A. citratus*, which yields lemon grass oil, and *A. Schœnanthus*, Linn. [*A. Martini*, Roxb.; *A. Pachnodes*, Trin.; *A. Nardoides*, Nees; *A. Calamus Aromaticum*], which is named "ginger grass" by Europeans. The last is of all the *Andropogons* the best known, and is used for adulterating otto of rose in European Turkey.

It is a curious fact that its Hindustani name is closely similar in sound to the word "rose." Thus, under the designation *Rusa, Rowsah, Rosa, Rose*, or *Roshe*, it is exported in large quantities from Bombay to the ports of Arabia, probably chiefly to Jeddah, whence it is carried to Turkey by the Mohammedan pilgrims. In Arabia and Turkey it appears under the name of *Idris Yaghi*, while in the otto-producing districts of the Balkan it is known, at least to Europeans, as "geranium oil," palmarosa oil. [This is not quite correct. Palmarosa oil is distilled from a species of geranium.—Ed. *C. & D.*] Before being mixed with otto the oil is shaken with water acidulated with lemon juice, and then exposed to the sun and air. By this process the oil loses its penetrating after-smell, and acquires a pale straw color.

The optical and chemical differences between grass oil thus refined and otto of rose are slight, so that when mixed with otto the ginger grass oil is not easily detected. Mrs. Lisboa proceeded to describe a new species of *Andropogon*, which, as fas as her knowledge and reading go, has not been described before. She has named it *A. odoratus*. It is known to the natives as *Gawat wedi*. Mrs. Lisboa came across it while arranging plants and dissecting spikelets of grasses for Dr. Lisboa.

Description.—Culm erect, 3–5 feet high, sometimes branching from the lower part, glabrous; nodes long bearded. Leaves lanceolate, cordate at the base, acute or acuminate, with a few long hairs; the lower cauline and radicle leaves long, the upper small, but their sheaths very long. Ligula small. Spikes numerous, erect, branched, pedicellate (the pedicel of the lower spikes longer), and congested at the end of a long peduncle without a sheathing bract, and forming an erect, dense, ovoid panicle. The rachis, pedicel, and the spikes covered with long silky hairs. Spikelets nearly two lines long, of a purple color, the sessile and the pedicellate nearly similar; outer glume of the sessile spikelet rather thin, many-nerved, somewhat obtuse, and covered with long silky hairs, with a pit in some spikelets of the same plant, and absent in others; second glume as long as the first or a little longer, but broader, thin, and keeled; third glume thinner and hyaline; fourth glume smaller, or an awn ½ to 1 inch long, with an hermaphrodite flower at the end of the pedicel. Pedicel of the pedicellate spikelet covered with white hairs, but the spikelet almost free of hairs. Outer glume stiff, with five or more nerves, not prominent, almost obtuse; second glume thinner, with three nerves somewhat broader, but as long as the first; third glume hyaline, smaller; fourth glume very small, hyaline or none; no awn; at the top of the pedicel three stamens not well formed, and not as large as in the hermaphrodite flower.

This grass is common at Lanowli on the right side of the station in the fields beyond the woods, where it grows along with *Pollinia tristachya*, Thw., *Ischæmum laxum*, R. Brown, *Arundinacea nepalensis*, Trin., and other annual grasses. The purple-colored spikes of *A. odoratus* and *Pollinia tristachya* congested at the end of long peduncles form a most elegant and beautiful feature of the scenery of the field toward the end of the rainy season. It is said to be not uncommon at Khardi, Tanna, and the specimen under notice was found in the collection received from this district.

From the description this *Andropogon* would appear to belong to the section *Gymnopogon* and is different from all other aromatic *Andropogons*. The leaves and the inflorescence also, when pressed between the fingers, emit an odor altogether different. A small quantity of volatile oil was submitted. It was distilled by Mr. Prebble, of Messrs. Kemp & Co., and was found to be of a beautiful golden yellow color. The odor of the

oil of the new species is soft, sweet, and more agreeable than that of *A. Martini;* and if it be manufactured on a large scale with great care, it may prove superior even to that of *A. nardus* and *A. citratus.*

A NEW PARASITE OF BIRDS.

THE group of plumicolous Sarcoptides, acaridans which live upon birds, is one of those that includes the strangest and most interesting forms for study. The species shown in Fig. 1 (*Chirodiscus amplexans*) belongs to the group Oustaletia. It is very simple in form, but the structure of its fore legs is entirely abnormal in this group, and even differs from everything known up to the present in the Arthropod branch. In fact, in the acaridans that live in the plumage of birds, the fore legs always terminate in an *ambulacrum* or bell-shaped sucking disk, which permits them to fix themselves in any position to the surface on which they rest, just as flies do when they walk upon a mirror or a ceiling.

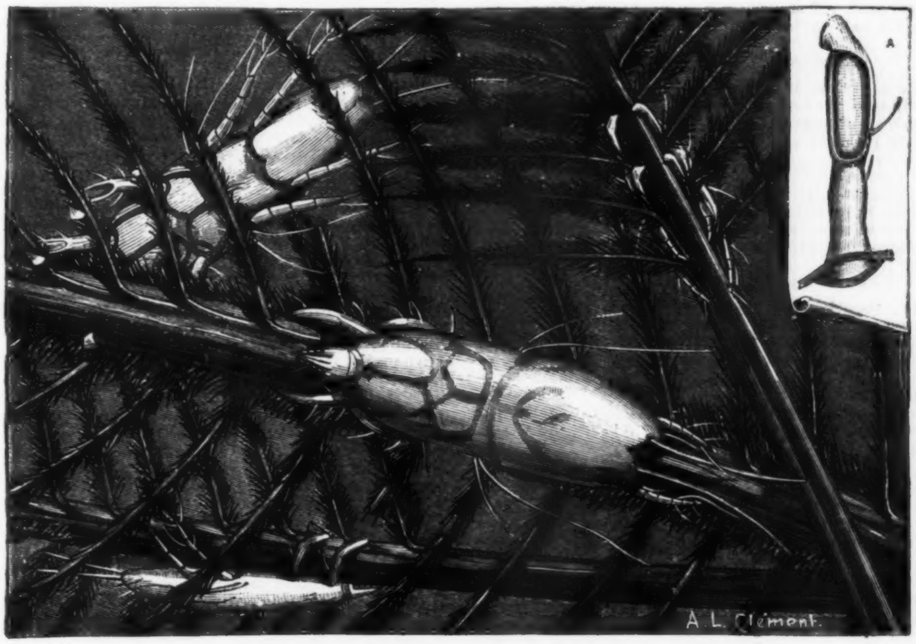


FIG. 1.—A NEW BIRD PARASITE (HIGHLY MAGNIFIED).

The *Chirodiscus amplexans* is an exception in this respect. Its two pairs of hind legs are alone provided with sucking disks, and these exhibit the normal conformation. As for the two fore pairs, they have a very different form and resembles paddles or fins rather than the legs of a terrestrial animal. Deprived of the terminal sucking disk, they are flattened, and expanded into an elliptical paddle which comprises two-thirds of the limb and exhibits an internal concavity. Finally, and this is the most remarkable point, the five articulations that constitute the normal leg in the Sarcoptides are consolidated into a single rigid joint, so that the highest power of the microscope shows no trace of sutures. This must give much strength to the claw formed by the approaching of these legs. This supposition is confirmed by an examination of the chitinous plates of the external skeleton which are observed under the abdomen, and to which the muscles of the legs are attached. These plates, as may be seen from the figure, are much developed, and are united with each other upon the median line by way of a sternum. If we examine these legs more closely, we shall see (Fig. 1, A) that the concave disk that forms the essential part of them is bordered with a strong callosity, so that we have a right to suppose that the acaridan is capable of increasing the concavity by means of special muscles when this surface is applied to a cylindrical object, or, in other words, of producing a vacuum in it (as in the sucking disk), thus increasing the adhesive power of the leg.

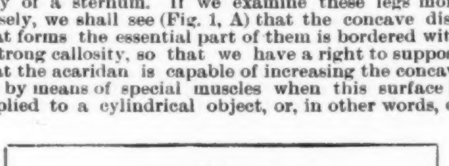


FIG. 2.—MAXILLÆ, PALPI, AND LEGS OF MYIOBIA MUSCULI.

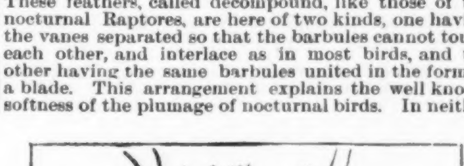


FIG. 3.—LABIUM AND TENTACLES OF LISTROPHORUS GIBBUS.

An examination of this curious leg thus puts us upon the track of its uses. Despite its superficial resemblance to a paddle, there is no reason for comparing it with the natatory legs of the Phyllopods—aquatic crustaceans having very different habits from those of the *Chirodiscus*, which lives in the plumage of a bird. Moreover, the curve of this leg is much stronger than that of a paddle. The disk bears more resemblance to the palm of a hand destitute of fingers, or the fingers of which are all consolidated. On the rare occasions in which the *Chirodiscus* is obliged to walk upon a plane surface, its movement must be singularly embarrassed. Like certain Edentates (Myrmecophaga) whose fore legs are armed with huge nails, it is capable of resting only the external edge of the limb upon the ground. On the contrary, this arrangement is very favorable for climbing, and it seems evident that the fore legs of the *Chirodiscus* are used by it for firmly grasping the quill of its host's feathers. We shall see that these feathers have a special structure that in a manner necessitates this abnormal form. But, in the first place, it will be well to ascertain whether in the same group of acaridans there do not exist some types that have habits and a conformation that are analogous. We find such types among the acaridans that live, not upon birds, but upon mammals—animals covered with cylindrical and branchless hairs. One species belonging to the family Trombidides, and living upon the mouse, the *Myiobia musculi* (Fig. 2), has two fore legs which are different from one another, and are transformed into two hooks or cramps adapted for seizing the hairs of the head of the animal upon which it lives, but the first pair alone is modified, and the number of articulations, though reduced, is three very distinct ones.

Another acaridan, belonging to the Sarcoptides, like the *Chirodiscus*, has hind legs that are deprived of sucking disks, and that are flattened and incurved so as to grasp hairs; it is the *Myocoptes musculinus.* The articulations of the leg are reduced to four, but remain distinct and movable.

In the *Listrophorus gibbus*, an acaridan of the same family, living upon the rabbit and hare, we find something that has more resemblance to the *Chirodiscus.* But here the claw that fixes the animal to the hairs, and which, by its form, recalls the clasp of a candle shade, is formed by the lower lip (Fig. 3), and not by the legs.

The *Chirodiscus amplexans* lives upon the great goatsucker of Australia (*Podargus strigoides*). The acaridan is not more than $\frac{1}{10}$ of a millimeter in length. The male differs from the female only in the notch in the abdomen. It is destitute of genital sucking disks, and this allies it to the Dermoglyphs.

If we examine the feathers of the bird with a lens, and more particularly those of the head and neck, the region where the parasite is found, we shall ascertain the mode of organization and the habits of the latter. These feathers, called decompound, like those of the nocturnal Raptores, are here of two kinds, one having the vanes separated so that the barbules cannot touch each other, and interlace as in most birds, and the other having the same barbules united in the form of a blade. This arrangement explains the well known softness of the plumage of nocturnal birds. In neither case can the acaridan find a place of refuge in the felting of the barbules, and can rely only upon the adhesive force of its legs to protect itself from shocks and from the wind produced by the flight of the bird. E. Verreaux, who has had an opportunity of observing the goatsucker in its native country, says that in the day time it remains in the trees, its body gathered up into a ball, the neck hidden, the feathers bristling, and it resembling mammals rather than birds. The softness of the decompound plumage adds still further to the resemblance.

The *Chirodiscus amplexans* appears to be quite rare. Despite all examinations of the *Podargus* and other Caprimulgides, but three specimens have been found, a male and two females. Still, knowing that the same forms of acaridans are usually found upon all the birds of the same family, it is expected that this type will be met with upon the European goatsucker, *Caprimulgus Europæus.—La Nature.*

MAIZE OIL IN PHARMACY.

By GEO. W. KENNEDY, A.P.A., Pottsville, Pa.

IN response to Query No. 11, the accepter, after some reflection, concluded to deviate a little from the query by furnishing some information regarding the extraction of the oil, its properties, cost, etc., which to some may not be new and uninteresing, while to others it will be listened to and read with interest and benefit.

J. U. Lloyd, in a paper read before the Ohio State Pharmaceutical Association, 1888, says: "It has been found in the making of starch, and perhaps in other directions as well, that it is desirable to get rid of the germs of the corn, as, for reasons that it is unnecessary for me to mention, this germ is objectionable in these manipulations.

"In order to accomplish the last result, a machine has been devised that degerminizes the corn, throwing the hard, starchy part of the corn in one direction, and separating the germs in another, and this method can be, and is, applied to the making of starch in large quantities, and is found to be of great assistance and advantage. Naturally, there was an accumulation of these excluded germs, which, as is well known, constitute a considerable proportion of the corn, and they became a by-product. They are found to be valuable as a feed for stock, but really were too 'rich' for such purposes, containing, as they did, a large amount of oil, the oil of the corn being almost altogether found in the germ. In order to render this material more acceptable as a feed for stock, a company was recently established for the purpose of squeezing the fixed oil from the germs, and thus improving the feed meal. A plant was established a few months ago (the only one in existence now, I learn), in the city of Cincinnati, for this purpose, and is now in operation. The method is very simple. The germs are conveyed from the factories, and are first purified by separating from them a considerable amount of bran or husk of corn that adheres to or is mixed with them. They are then steamed under pressure so as to soften them, after which in the usual manner, by means of hydraulic presses, the oil is squeezed from them. The process is a very simple one and yields an oil cake which, when ground into meal, is found to be exceedingly valuable as a feed for stock, the manufacturer claiming that it is superior to corn meal that is made from the whole corn. Thus it is that in addition to the oil cake, which is the prime object of the industry, there is an accumulation of the fixed oil. Inasmuch as the industry that yields the oil in course of time promises to increase, and the oil to be obtained in unlimited amounts, car load lots or otherwise, it is not probable that the output will ever be less than the demand. It is peculiarly of necessity an American production, and will always, probably, be at our command. In car load lots it can be had at 40 cents per gallon."

Prof. Chas. O. Curtman, of St. Louis, has determined its character as follows:

"Oil from embryo of Indian corn in unrefined state has a specific gravity of 0·916 at 15° C., which is nearly that of pure olive oil (0·915 to 0·918). The Elaidin test shows the presence of a large quantity of olein intermediate in quantity between olive and cotton seed oils. Its color is pale yellow brown; its odor and taste that of freshly ground corn meal. It belongs to the non-drying group of the vegetable oils, the experiments showing that a very thin layer on paper does not, in three weeks' time, form a pellicle on the surface exposed to air. In this respect it closely resembles the oils of olive, almond, colza, rape seed, etc. It does not very rapidly become rancid by exposure to air, and in this regard compares favorably with the best oils. Its use produces no specific purgative effect, any more than olive oil."

Analysis by F. Williams, Liverpool, Eng.:

Fatty acids (free)	0·98
Total fatty acids	96·70
Unsaponifiable, mucilaginous, and albuminous bodies	1·34

The sample is a non-drying oil, and very easy of saponification. Being in a crude state, direct from the mill, I have subjected a portion of the oil to a process of purification or refining, finding the loss sustained to be a little over four per cent.

I am satisfied, from the results obtained by other experimenters as well as my own, that corn oil is by far more applicable in pharmacy than cotton seed oil. It saponifies readily without separation, and even after standing a considerable time, separation was not perceptible, which is not the case with cotton seed oil. As it is quite difficult in saponification with either lime or ammonia, a very unreliable preparation was obtained in lini. plumbi. Not one of these preparations was found to be permanent when made with cotton seed oil, by the writer.

The oil used in conducting my experiments was obtained through the kindness of Prof. J. U. Lloyd. It is of a bright yellow brown color, bland, about as thick as olive oil, a slight characteristic odor of fresh corn, and has a sp. gr. 0·923 at 60° F.

With the view of answering the query in a satisfactory manner, I decided to make all of the preparation in which a fixed oil is used, substituting maize oil for cotton seed or other fixed oil.

The following fifteen officinal preparations embrace all in which I experimented: ceratum camphoræ, ceratum cetacei; charta cantharidis, collodium flexile; emp. ammoniaci cum hydrargyro, emp. hydrargyri, emp. plumbi; linimentum ammoniæ, linimentum calcis, linimentum camphoræ, linimentum plumbi subacetatis, linimentum sinapis comp.; unguentum aq. rosæ, ungt. diachylon, ungt. hydrargyri nitratis.

CERATUM CAMPHORÆ.

Camphor liniment (made with corn oil), three parts	3
Corn oil, twelve parts	12
Cerate, eighty-five parts	85
To make one hundred parts	100

Mix the camphor liniment and the corn oil and incorporate the cerate. The substitution is a decided improvement in this preparation, as it is free of the

disagreeable odor of olive oil, which is frequently noticed in the old formula.

CERATUM CETACEI.

Spermaceti, ten parts	10
White wax, thirty-five parts	35
Corn oil, fifty-five parts	55
To make one hundred parts	100

Melt together the spermaceti and wax, then add the corn oil, previously heated, and stir the mixture constantly until cool. The use of corn oil in this preparation is also an improvement over the officinal, as it is free of any unpleasant odor, and is bland and pleasant.

CHARTA CANTHARIDIS.

White wax, eight parts	8
Spermaceti, three parts	3
Corn oil, four parts	4
Canada turpentine, one part	1
Cantharides, in No. 40 powders, one part	1
Water, ten parts	10

Mix all the substances in a tinned vessel and boil gently for two hours, constantly stirring. Filter through a woolen strainer, without exposing, and by means of a water bath keep the mixture in a liquid state in a shallow, flat-bottomed vessel with an extended surface. Coat strips of sized paper with the melted plaster, on one side only, by passing them successively over the surface of the liquid, and cut the strip when dry into rectangular pieces. These papers are equal, both in activity and appearance, to the officinal, and the corn oil is therefore a good substitute.

COLLODIUM FLEXILE.

Collodium, ninety-two parts	92
Canada turpentine, five parts	5
Corn oil, three parts	3
To make one hundred parts	100

Mix them and keep the mixture in a well stopped bottle. This preparation is as satisfactory as when made up with castor oil.

EMPLASTRUM AMMONIACI CUM HYDRARGYRO.

Ammoniac, seven hundred and twenty parts	720
Mercury, one hundred and eighty parts	180
Corn oil, eight parts	8
Sublimed sulphur, one part	1
Dilute acetic acid, one thousand parts	1,000
Lead plaster, a sufficient quantity.	
To make one thousand parts	1,000

Digest the ammoniac in the diluted acetic acid, in a suitable vessel, avoiding contact with metals, until it is entirely emulsionized; then strain and evaporate the strained liquid by means of a water bath, stirring constantly, until a small portion taken from the vessel hardens on cooling. Heat corn oil and gradually add the sulphur, stirring constantly until they unite; then add the mercury, and triturate until globules of the metal cease to be visible; next add gradually the ammoniac while yet hot and, finally, having added enough lead plaster previously melted, by means of a water bath, to make the mixture weigh one thousand (1,000) parts, mix the whole thoroughly. The substitution in this case also proved satisfactory.

EMPLASTRUM HYDRARGYRI.

Mercury, thirty parts	30
Corn oil, ten parts	10
Resin, ten parts	10
Lead plaster, fifty parts	50
To make one hundred parts	100

Melt the corn oil and resin together, and when the mixture has become cool, rub the mercury with it until the globules of the metal cease to be visible; then gradually add the lead plaster, previously melted, and mix the whole thoroughly. The use of corn oil in this preparation gave perfect satisfaction, the globules of mercury being completely extinguished, and consequently the plaster good.

EMPLASTRUM PLUMBI.

Oxide of lead, in very fine powder, thirty-two parts	32
Corn oil, sixty parts	60
Water, a sufficient quantity.	

Rub oxide of lead with one-half of the corn oil, and add the mixture to the remainder of the oil contained in a suitable vessel of a capacity equal to three times the bulk of the ingredients. Then add ten parts of boiling water, and boil the whole together until a homogeneous plaster is formed, adding from time to time, during the process, a little water, as that first added is consumed. Lead plaster thus prepared is pliable and tenacious, free from greasiness or stickiness, and is entirely soluble in warm oil of turpentine, which shows the absence of uncombined oxide of lead. This plaster, made according to the above formula, gave perfect satisfaction; the only noticeable difference being in color, which was very much darker than the officinal.

LINIMENTUM AMMONIÆ.

Water of ammonia, thirty parts	30
Corn oil, seventy parts	70
To make one hundred parts	100

Mix together with agitation.

Oil of corn seems to be particularly adapted in the making of this liniment. The preparation is very satisfactory, producing a beautiful creamy and permanent liniment. Cotton seed oil in my hands has always been very unsatisfactory, and practically a failure.

LINIMENTUM CALCIS.

Solution of lime, fifty parts	50
Oil of corn, fifty parts	50
To make one hundred parts	100

This preparation was equally as satisfactory as the linimentum ammoniæ, being smooth and of a good consistence.

LINIMENTUM CAMPHORÆ.

Camphor, twenty parts	20
Corn oil, eighty parts	80
To make one hundred parts	100

Dissolve the camphor in the oil at a moderate heat. Camphorated oil prepared with corn oil is unobjectionable.

LINIMENTUM PLUMBI SUBACETATIS.

Solution of subacetate of lead, forty parts	40
Corn oil, sixty parts	60
To make one hundred parts	100

Mix them by frequent agitation.

This yields a yellowish white emulsion, which does not separate on standing, but gradually stiffens. The corn oil can be used to advantage in this preparation.

LINIMENTUM SINAPIS COMPOSITUM.

The substitution of corn oil for castor oil in this preparation is very unsatisfactory, as the corn oil is insoluble in the alcohol used, which produces a very unsightly product.

UNGUENTUM AQUÆ ROSÆ.

Corn oil, fifty parts	50
Spermaceti, ten parts	10
White wax, ten parts	10
Rose water, thirty parts	30
To make one hundred parts	100

Melt together by means of a water bath the oil, spermaceti, and wax. Then gradually add the rose water and stir the mixture constantly while cooling.

The corn oil seems to be admirably adapted in preparing this ointment, as it produces a beautiful, smooth, rich-looking salve. The only difference between this and the officinal is in color, the latter being of a pure white, the former of a very light straw color.

UNGUENTUM DIACHYLON.

Lead plaster, prepared with corn oil, sixty parts	60
Corn oil, thirty-nine parts	39
Oil lavender, one part	1
To make one hundred parts	100

Melt together the lead plaster and corn oil at a moderate heat, then, having permitted the mass to become partly cool, incorporate with it the oil of lavender, and stir constantly until cool.

The only objection I know to this formula is the darker color of the ointment.

UNGUENTUM HYDRARGYRI NITRATIS.

Mercury, seven parts	7
Nitric acid, seventeen parts	17
Corn oil, seventy-six parts	76

Heat the corn oil in a glass vessel to a temperature of 70° C. (158° F.), then add without stirring seven parts of nitric acid. Continue the heat so long as a moderate effervescence continues, and allow the mixture to cool. Dissolve the mercury in the remainder of the nitric acid with the aid of sufficient heat to prevent the solution from crystallizing. Add this solution to the mixture before it has become entirely cold, and mix them thoroughly, avoiding the use of an iron spatula.

This preparation, made as above, is satisfactory, excepting that it does not become as thick as the officinal.

In answering Query No. 22, I would say that corn oil can be used in nearly all cases where other fixed oils enter as one of the component parts of the preparation; in some formulas with better results, others equally as good, and a few not so good, as this paper has proved.—*Western Druggist.*

THE INTERNATIONAL CONGRESS ON HYPNOTISM.

Of the many congresses recently held in Paris, that on "Hypnotism, Experimental and Therapeutic," if not altogether the most interesting, was, at any rate, the most novel, for it was the first international congress ever held on this subject, and, in fact, one of the rare attempts made by competent men assembled together to rescue it from the hands of charlatans, quacks, and conjurors.

Speaking generally of the medical profession, and especially of the English section of it, the tendency hitherto has been to look askance on the whole surroundings of the alleged phenomena associated with what is known since recent times under the name of "hypnotism." Nay, more: the inclination to look with dubious misgivings on any one in the profession who meddled in the matter, or who claimed any therapeutic or other good effect, or even real existence, for the cerebral phenomena in question, has been manifestly the fashion; rather has the whole thing been condemned and passed over as deceptive or hysterical trickery. Enthusiasts have from time to time risen in its defense, who, in claiming everything for it, have, like most enthusiasts, ridden their hobby to death, but who have, doubtless, in a large measure owing to this exaggerated faith, hitherto only succeeded in burning their fingers. Warned by such examples and the general suspicion pervading the whole hypnotic atmosphere, ordinary individual inquirers have, with comparatively rare exceptions, until now, rather suppressed the natural curiosity within them to probe the matter to the bottom, or have done so, as it were, by stealth; and hence, whatever there is, good or bad, false or true, in these mental phases has been entirely abandoned to mountebanks and showmen. This certainly seems, after all, a puerile attitude to adopt in reference to the question. It would appear better, instead of looking on it as a double-edged tool and relegating it to the realms of doubt and suspicion, or putting it out of sight in the shade of some abstrusely written psychological and rarely read volume, to bring it manfully into the light of ordinary medical instruction and discussion, so that general experience and inquiry might elucidate it, and by so doing finally condemn or establish it in its claim to a respectable existence or its right to be admitted among our therapeutic methods.

Now the congress just held marks the first serious effort to bring together the scientific men of different nations for the express purpose of arriving at an international understanding on the subject. It held its sittings in the Trousseau lecture theater of the Hotel Dieu, which was tastefully decorated with the flags of the several European and American nations, but which proved much too small to contain the number of members and visitors. Over a hundred medical men, French and foreign, responded to the summons of the organizing committee. Among the foreign were MM. Dekhterew, of St. Petersburg, Delbœuf, of Liege, Forel of Zurich, Ladame, of Geneva, Masonin, of Louvain, and Semal, of Mons. M. Dumontpallier, the president, at the opening sitting, traced rapidly the history of scientific hypnotism, the progress of which was in a large measure due to the researches of the school of the Salpetriere and of that of Nancy, but the popular knowledge of which in the profession dated back to very recent days only. The study of scientific hypnotism, said the speaker, began in 1876 only, when a commission was nominated by the Biological Society to report on the experiments in metallo-therapie of Burq. The recognition of certain effects produced by metals led the commission to the study of hypnotism, which produced analogous phenomena. M. Dumontpallier, at the Hopital la Pitie, and M. Charcot, at the Salpetriere, carried on this inquiry. Then the Nancy school, directed by Liebeault, Bernheim, and Liegeois, worked out one branch or factor in hypnotism—viz., suggestion—which it made peculiarly its own. Indeed, M. Bernheim endeavors to show that under suggestion may be included nearly all the hypnotic phenomena. It is undoubtedly a powerful element, but many other procedures and physical agents may be used to bring about the hypnotic state independently of suggestion. Thanks to the works, then, of Ladame, Grasset, Voisin, Yung, Delbœuf, Forel, Mesnet, and Azam, hypnotism now finds its place in the academies, and no longer meets with opposition from scientific minds. It was still, however, necessary, in order to place this progress on a solid basis, that all experiments should be conducted with scientific reserve and closely criticised, and to consider nothing a demonstrated fact unless it were confirmed by all or the majority of inquirers. Such in *resume* was the opening address of the president. The first question which was put before the meeting for consideration was, "The prohibition of all public performances in hypnotism and the necessity of putting hypnotism under legal control." M. Ladame, of Geneva, strongly insisted on the necessity of interdicting all public displays of hypnotism. The discussion at the Academy of Brussels in 1888 sufficiently revealed the dangers to be apprehended from such displays. He himself had seen at Neuchatel a veritable post-hypnotic epidemic. MM. Bourdon and Dekhterew supported M. Ladame, and added that the last Russian psychological congress had voted prohibition. Finally the proposition was put to the vote and carried, and to it was added the following resolution, which was also carried—viz., "That it is desirable that the study of hypnotism and its therapeutical applications be introduced into the curriculum of medical education."

MM. Van Renterghem and Van Eeden of Amsterdam next communicated the results obtained in the treatment of 414 cases made up of organic diseases of the nervous system, neurotic, mental, and neuralgic cases, etc. The method adopted was the Nancy one by suggestion. In 17 cases there was no result, in 92 slight amelioration, in 98 marked amelioration, and in 104 cases cure; 57 cases were not worked out.

After this the congress proceeded to the discussion of the second question—viz.: "What is the relative value of the different methods of bringing about the hypnotic state and of augmenting suggestion from a therapeutic standpoint?" M. Bernheim, in discussing these points, said that to define hypnotism as induced sleep was not sufficient, for all hypnotized subjects do not sleep. Some have profound sleep, with amnesia on waking; others also sleep deeply, but recollect their hypnotic period; a third category fall into a light sleep only; and, finally, there are others who do not sleep, or believe they do not. The degree of suggestibility varies with each one of these groups, and is very high in the first; the second are also subject to fairly complete suggestion, but in the remaining groups it is incomplete. For example, one can obtain suggestion of movement and sensation, but not hallucinations. A subject may, however, pass from one to another of these categories. The hypnotic condition, then, is not mere sleep, but a peculiar psychical state, the sleep indicating a profound condition of suggestibility only. The first method employed to bring about hypnotism is that known as Braid's, which consists of fixation by means of some brilliant object. This is the method employed, more or less modified, by the Salpetriere school to bring about that which is called "le grand hypnotisme" and its three stages. The second method is that which is known as the "verbal suggestion" of Faria. Besides these, there are various other methods, all of which may be successful provided the subject is forewarned. All these methods sum themselves up under suggestion. The fatigue caused by the fixation of vision and the divers passes only acts by "suggesting" the idea of sleep. The so-called hypnotic zones do not exist, provided suggestion is avoided. Since all resolved itself into suggestion, "verbal suggestion" was, in the speaker's opinion, the best method. Here he described in detail the methods and practice of verbal suggestion which are to be found in his book on hypnotism. The greatest difficulties experienced by a novice in operating came from "contre suggestions," which resulted from his own hesitations, none of which escaped the observation of the subject, but with practice one can in hospital service hypnotize nine out of ten patients. In order to awaken them, affirmation sufficed, provided it be done without hesitation. M. Bernheim went on to say that suggestion is possible even in a state of wakefulness in certain subjects, in whom every idea is immediately transformed into an act as if the cerebral initiative had not time to intervene. What he called suggestive psycho-therapeutics had for its object the cure of the patient by causing his brain, whether hypnotized or not, to be possessed of the persuasion of cure or the cessation of his symptoms. Suggestion, he declared, had always been exercised, although unconsciously, by physicians. The prescription of inert substances under scientific names was nothing less, and he

would add his firm belief that the different methods of hydro-therapeutics, electro-therapeutics, and even the much discussed suspension in tabes, acted in a like manner. Let us admit, then, concluded the orator, the importance of the *role* which the mind has in morbid phenomena, and allow that, as we had psychology, so we also had psycho-therapeutics.—*Lancet.*

THE TREATMENT OF PNEUMONIA BY TEPID BATHS.*

By GEORGE N. KREIDER, A.B., M.D., Springfield, Ill.

DURING the past few years much has been written about the alarming mortality of pneumonia. Men whose wide experience has extended over a long period of years affirm that the death rate is much higher under the present accepted modes of treatment than it was forty years ago, when the pathology of the disease was almost unknown.

It would hardly seem that our therapeutics of pneumonia is commensurate with our knowledge of its etiology and pathology. Some endeavor to explain this increased death rate by supposing that a change in the character of the disease has occurred in the last half century, while others claim that the statistics are made more unfavorable by the fact that a large number of poorly nourished and dissipated persons are now treated in the large city hospitals where these comparisons have been made. Whatever may be the explanation, it remains true that the mortality rate is extremely, and I believe unnecessarily, high. The high mortality rate of pneumonia and typhoid fever in America is the medical opprobrium of our country. Dr. Osler says death in this disease is most frequently due to high temperature and heart failure, and it is against these very grave symptoms that our present treatment is least effective. The same statement might be made, and with equal truth, concerning typhoid fever.

The newer antipyretics, antipyrin and antifebrin, have their place, and if used with proper precautions may render material assistance; but, used in a routine and indiscriminate manner, they are capable of doing more harm than good. They may enable us to reduce the height of the temperature, but are not lessening to any great extent the mortality of this disease. Too frequently they depress the heart's action and disturb the stomach, and thus cause complications of the gravest nature by preventing the patient's taking a sufficient quantity of nourishment and by impeding the circulation of blood through the lungs. After careful consideration, and influenced by the successful use of the ice coil in my practice, in the treatment of typhoid and puerperal fever, I came to the conclusion some time since that a change in my method of treating pneumonia was desirable.

Relying upon the statements of well-known German authorities, I decided to make a fair and impartial trial of tepid baths in grave cases. The employment of these means is so contrary to all our American teachings and traditions that it is only in the last six months that I have gained sufficient courage to employ them. So great is the fear of cold in the minds of both the laity and the profession that it is doubtful whether I would have been permitted to make the experiment earlier in my professional career. For this reason the number of cases which I am able to relate in support of my views is not as great as would be desirable. However, I believe that a careful clinical study of a few cases is quite as valuable in proving principles as tables embracing an indefinite number can be.

Modern investigation has certainly proved that micro-organisms of some kind, and not colds, are the immediate cause of this disease, and in the light of this discovery all mistaken prejudice against baths and cold applications must fall to the ground. Pneumonia is essentially a fever, which should be treated, as far as its effects on the respiration, temperature, heart, and skin are concerned, like any other fever. I do not pretend to say that every case of pneumonia should be treated by baths.

Strumpell wisely says it is disadvantageous, if not injurious, to give a patient baths if the disease is progressing favorably, for almost every bath has some disagreeable features which should be avoided if possible. All these disagreeable features vanish in a bad case. The possibility of the necessity for baths should be had in mind on assuming charge of every case of pneumonia, and arrangements made accordingly. A portable bath tub should be in storage from which it can be taken at a moment's notice.

The dealer of whom I procure the tubs rents them out at a reasonable figure, and is easy of access day and night. A portable tub can be placed by the bedside and the patient lowered into it without the least physical exertion on his part. The patient should be placed on a single bedstead, with low head and foot pieces, for convenience in handling sponges and towels; dry sheets and blankets should be on hand in abundance for use during and after the bath. After the tub is once properly filled, very little more disturbance is necessary, since the water will retain its heat for a long time and one or two buckets of hot water will bring it to the required temperature. The reasons for resorting to the treatment should be fully explained to the relatives, and their hearty co-operation secured. I have thus far found little opposition where this treatment was proposed, and this was usually volunteered by some officious neighbor whose medical attendant "never did such a thing." The physician himself must superintend and assist in giving the baths. Especially is this the case in children, whose expression of fear will often influence the parents to the detriment of the treatment.

I have used baths in the treatment of six cases. All have not been successful, but in none were any bad symptoms caused by the bath; on the contrary, in every case the patient came out of the tub refreshed and improved, for the time at least. The first case treated was Mrs. F. W. T——, aged thirty-five, seen with Dr. Dresser in the second week of puerperal fever, and with strength reduced by that disease. She developed at this time catarrhal pneumonia of the right lung, beginning with a severe chill, pain in the side, and elevation of temperature, pulse and respiration. She was treated with antipyretics, stimulants, and expectorants for six days, without very apparent benefit. Matters had seemingly reached a critical point. The pulse and temperature remained elevated, and little or no material was raised from the lung. There was coma vigil, muttering delirium, and picking at the bed clothes. I finally urged, as a last resort, the employment of a bath, to which my colleague finally consented.

To give it we were obliged to carry the patient to another room and immerse her in a stationary tub, which was only accessible from one side. This increased the labor of the treatment a great deal, and minimized its benefits. The temperature of the baths was 98° F.; temperature of the patient, 103° F. The bath was given at 9 P. M., and the condition of the patient being alarming, I remained all night an anxious watcher at her bedside. My concern may be better imagined than described. I had, with many mental misgivings, urged a procedure which until then, I believe I may say, was unknown in the community, and severe condemnation certainly awaited its failure. During the night some encouraging symptoms appeared. She was bathed twice the next day, each time with some slight benefit, but it was not until a somewhat more prolonged bath was given, on the following morning, that the rusty-colored sputa began to come away in any quantity. Four baths in all were given. As showing the condition of the patient and the value of baths, I may relate that her husband, an unusually well posted clergymen, had cabled the patient's sister in London the news of her impending death. The patient has fully recovered, a result which I think would scarcely have been possible without the baths. One interesting feature of this case is the comparatively low range of the temperature. It never went above 103·5° F. The fever was not entirely controlled by the baths, as it went to as high a point after we had discontinued them as before; but their effect in loosening the exudation and stimulating expectoration and the heart's action was so marked as to be beyond question.

The second instance in which the baths were employed was in the case of W. K——, aged twenty-three, seen with Dr. Walter Ryan, in the fifth day of the disease. The temperature was nearly 105° F.; respirations, 64; and pulse, 144. While on a drunken spree he had been stricken with a severe type of the disease, and had been treated with antipyretics and stimulants *secundum artem* by Dr. Ryan. It was our opinion that death was inevitable in a few hours, but influenced by the brilliant success in my first case, it was decided to give him the benefit of the baths. They failed to rescue him, but not only did they do no harm, but, we believe, sustained life thirty hours longer than would have been possible without them.

The next case to which I successfully applied the treatment by baths was Willie G——, aged ten. On the third day of an attack of measles he developed pneumonia, and it was only then that I was called to attend him. I found his respirations 84 per minute, pulse above 160, blueness of the lips, and temperature 104·8° F. I lost no time, after informing the family of the gravity of the case, in preparing to give him a bath. In default of a regular bath tub, and as I deemed an immediate bath imperative, we made use of a large-sized wash tub in which the boy seated himself, while myself and assistants poured the water over him. He came out of the tub improved. Six hours later, finding alarming symptoms again present, I put him in a second bath. This completed the good effects of the first and started him on the highway to recovery. Eighteen hours after the first bath his respirations were 40; pulse, 126; and temperature, 102° F. Rapid convalescence follwed.

The fourth case is that of Mr. W. S——, aged twenty-five, whom I was called to see at a coal mining station ten miles from the city. Finding pneumonia of the right lung imminent, he was brought to the city by special train and placed in St. John's Hospital, where he soon developed the disease in its most severe type. The temperature reached the unusual figure of 106·2° F., and this despite the employment of antipyretics and the ice coil. When it reached the highest point, the unconscious patient was placed in a bath at a temperature of 95° F., where he was kept for ten minutes. This procedure was repeated in four hours. These two baths were sufficient to break the force of the disease, and steady and rapid improvement was noted from the time of their use. Expectoration, which had ceased with the appearance of the bad symptoms, became again abundant, consciousness was regained, and the heart's action improved. This patient weighed two hundred and eighteen pounds, but the labor of handling him was much less than was anticipated. The small number of baths required was the more remarkable because of his development of adipose.

The fifth case is that of M. J——, aged seven, whom I saw early in the disease, when there was probably little more than congestion present. The symptoms of pain in the side, distressing cough, and elevation of temperature and pulse were great enough to call for active treatment. Instead of giving the usual antipyretics I gave two tepid baths, and was thus enabled to change this picture to one of quietude and freedom from pain, and a rapid convalescence.

The sixth case was that of L. D——, aged sixty-nine, in which, unfortunately, the bath treatment was not given until after severe symptoms of heart failure had developed. The effect of the bath was good for the time being, and although the patient did not recover, the bath had nothing whatever to do with the fatal result, which was due to heart failure. My only regret is that the treatment was not instituted earlier in the case.

The results of my trial of this treatment, it will be seen, give a mortality rate of thirty-three per cent. This is not a very encouraging argument in its favor, but statistics in so small a number of cases should not be used in that way. As a result of my clinical study of the use of baths, I am prepared to indorse the statement of their good effects made by gentlemen high in authority and with a large experience in their employment. My two patients who died were already *in extremis*, and two of the cases of recovery were calculated to give as severe a test of the treatment as one is likely to encounter. The treatment means work on the part of the medical attendant, and he who prefers to write a prescription to using some physical exertion had better remain an advocate of antipyretic medication.

The conclusions I make in closing this very imperfect presentation of the benefits of baths in pneumonia are:

1. They should only be given in those cases which are not progressing favorably. 2. In severe cases nothing is calculated to give so much relief to all bad symptoms. They shorten the duration of the disease and of convalescence, and reduce the mortality. Liebermeister says it has been reduced in his hands from twenty-five to ten per cent. 3. Rules for selecting cases and administering baths cannot be rigidly given. The thermometer is not always the guide for their administration. Difficulty of respiration and lack of secretion should lead to their employment, regardless of the height of the mercury. 4. The temperature of the bath should be one hundred degrees or less, depending on the severity of the case and the condition of the patient. Baths of extremely low temperature I have not found necessary as yet, but should not hesitate to employ them if occasion should require. 5. Stimulants should be given just before entering and on coming out of the bath tub. The patient should not exert himself in the least. 6. The physician should himself superintend and aid in giving the bath. This rule could only be broken by having trained nurses who are competent to meet the emergencies which might arise.

* A paper read at the thirty-ninth annual meeting of the Illinois State Medical Society.—*Medical Record.*

THE BROWN-SEQUARD DISCOVERY.

By G. ARCHIE STOCKWELL, M.D., F.Z.S. (Member of New Sydenham Society, London), Detroit, Mich.

THE announcement made by Prof. Chas. Edward Brown-Sequard before the *Societe de Biologie*, of Paris, on the 8th of June last, has been received with emotions of mingled surprise, belief, and skepticism by the medical profession. Some of his academical colleagues, without inquiry as to the facts that are, or might be, embodied, found therein a source for gibes and ridicule as unseemly as they are ofttimes obscene. Certainly it would seem as if the age and previous standing of the eminent physiologist, to whom we owe nearly all that is known of neuro pathology and therapeutics, including the value of the *bromides*, should entitle him to at least respectful attention.

Again, most unfortunately, the matter has been taken up by the secular press in an almost indecent manner, and spread broadcast as an "Elixir of Life," the venerable professor being compared to Dr. Dee, Ponce de Leon, and the witches in Macbeth; besides, opportunity has been offered a large class of sensational practitioners and pseudo-medical men to advertise themselves and their wares.

But what are the real facts?

Simply, that Prof. Brown-Sequard, after nearly a quarter of a century of careful and conscientious experimentation, conducted in part upon himself, announced, he has reason to believe, a remedy of value, with the specific action of a cerebro-spinal stimulant, contained in the secretion of certain glandular structures intimately associated with the reproductive function!

Certainly there is little of the sensational in this, since the therapeutic action upon the economy of various animal substances has long been known, and their employment limited only by reason of the many difficulties attendant upon administration and preservation of such readily decomposable and highly nitrogenized structures. Further, Brown-Sequard's experiments were founded alike on scientific precedent and tradition, for those most conversant with the earlier history of civilization, and who have delved among the records of extinct and prehistoric nations, are well aware of the probability that, in many things pertaining to the phenomena and mysteries of life, the ancient philosophers were immensely our superiors. To-day we have returned practically to the theory of conception enunciated by Aristotle. The records of ancient Chaldea and Egypt, and the older books of Holy Writ, exhibit a familiarity with the physiology, pathology, and hygiene of reproduction, and of the generative apparatus, including functions, that are scarcely at all understood by moderns; while is also observed a veneration for specific glandular products that is not susceptible of explanation by any modern sanitary or philosophic hypothesis.

Turning to the history of Phallic worship, we find ourselves at the root of all science, as well as religion, in the veneration of the source of life and the creative principle. It was for an insult to Phallic doctrines that Onan was cursed, and we now know also that the crime that brought the fatal draught to Socrates was Phallic heresy.

It is a trite assertion of science that "no myth or tradition is without a basis of fact," and accordingly we find in Hebrew and Egyptian records evidence that the same product employed by Brown-Sequard was in vogue as a therapeutic measure in the earliest times. In the days of imperial Rome it entered into the "witch potions" dispensed to the libertine patrician youth and the elixirs employed by Nero and Caligula to sustain their prolonged and sensuous debauches. In the middle ages the repute of such preparations had no way lessened, but rather increased; and we find Phillipus Aureolus Theophrastus von Hornheim, better known, perhaps, as Paracelsus (1493–1541), who in many respects was four centuries in advance of his time, dispensing the same as the chief ingredient of potions that obtained a world-wide celebrity. That these were not original with him, but obtained from study in the Arabic and Saracenic schools, which until the downfall of the Moorish empire in Andalusia were the only accurate sources of scientific information and progress in Europe, is self-acknowledged.

Skipping now to the seventeenth century, we find the same products strongly lauded in the London Pharmacopœia of 1676 and Salmon's New Dispensatory of 1684. In the latter part of the next (last) century, however, these were abandoned, not because of any evidence of lack of therapeutic virtue and activity, but, as stated by the Encyclopedia Britannica, third Scotch edition (1788), "on account of inexpediency, viz., the difficulty of obtaining fresh as demanded, and the still greater difficulty of preserving." To day, too, in West Britain and portions of Scotland and Ireland, the same are employed by farriers (administered on a fasting stomach), to renew vitality in worn-out and jaded stockgetters, and with a degree of success, as must be admitted, entirely incompatible with the theory of mere coincidence.

Recognizing the possibility, not to say probability, of the correctness of Prof. Brown-Sequard's views, Mr. H. F. Mier, a well known chemist of Detroit, associated

with the scientific department of Parke, Davis & Co., undertook an analytical examination of glandular products such as are employed by Brown-Sequard, and succeeded in isolating a leucomainic alkaloid which under physiological investigation proved to be the active agent. This alkaloid has since been identified by Mr. Mier with *spermine*, announced by Schreiner in 1878, with the chemical formula of C_2H_5N, as existing not only in specific glandular products, but in the hearts and livers of calves, and upon the surface of morbid specimens that have long been immersed in alcohol. The phosphate of spermine (as it is now known to be) is identical with the so-called Charcot-Neuman's crystals, discovered some ten years earlier.

Further examination developed the fact that spermine exists in considerable proportion in all normal gray nerve matter of the brain and spinal cord: in oysters, eggs, mussels, lampreys, fish muscle, ova and milt: in the products of all atonic mucous membranes that develop excessive and abnormal secretion. Hence it appears also as a waste product in the expectoration of phthisis, senile and acute bronchitis, and emphysema with catarrh, and in the blood, spleen, and liver of anemics, and others afflicted with wasting diseases.

No little material for reflection is afforded in the fact that this product obtains in excess in the wasting diseases, notably leucocythæmia, where the proportion of white blood corpuscles to red is as one to *three*, against one to *three hundred and seventy-three* in health. Here spermine is found lacking in the brain, though it may be isolated from the elements in disproportionately large quantities: and the administration of iron, which decomposes in contact with alkaloid, forming soluble compounds, appears effective in restoring to the nervous system its proper tone, by again imbuing it with this product.

It is a well known physiological fact that most of those suffering from wasting diseases, such as tuberculosis, catarrhal pneumonia, anemia, phthisis, etc., where mucous membranes are involved, fail mentally and physically in a degree altogether disproportionate to mal-nutrition, also disproportionate to the amount of food ingested, digested, and assimilated; hence we are forced to look for some other agency than mere dynamic waste as physiologically understood. Again, the loss of vital portions of the sexual apparatus so completely transforms the individual mentally and physically, that physiologists have been forced to acknowledge a cause unknown, and inadequate of explanation by mere removal of glandular tissue. Such individuals are rarely long lived, are lacking in general brain activity, and devoid of normal economic *tone*. Again, it is an indisputable fact that genital affections of all classes are accompanied by wasting, excessive pallor, and general exhaustion of the economy, most manifest, however, in the central nervous system.

In the laboratory experiments of Mr. Mier, it was found that the *hydrochlorate of spermine* ($C_2H_5N.HCl$) is the most convenient and desirable form of the alkaloid, as it is most stable, and freely soluble in water, though scarcely at all so in alcohol or ether. It crystallizes in hexagonal prisms united in tufts, and resembles in no small degree the muriate salt of cocaine. It may be administered by the stomach, as well as subcutaneously, if desired, as it is non-toxic, dialyzable (and therefore readily absorbed), though to obtain its best action it should be employed only when the gastric functions are in abeyance, in order to insure its passage untransformed into the duodenum.

It has been supposed by some that the physiological effects observed by Brown-Sequard from the employment of crude glandular secretion might be due to the contained ammonio-phosphate of magnesium, or phosphatic salts, but experiments with spermine hydrochlorate, in which all ammonia and phosphoric acid combinations are eliminated, prove the alkaloid alone is the factor. The latter, employed subcutaneously in doses of $\frac{1}{10}$ of a grain, in dogs and cats, induced marked physical and mental activity and profound and prolonged stimulation of the genital system. In one aged animal, the vital processes were so far rejuvenated as to cause in three days the healing of an old suppurating, and hitherto intractable, sinus of two years' standing. The effects are not permanent, however, but wear off in from eight to thirty-six hours, according to circumstances, unless the injection is renewed.

These experiments, along with others undertaken in individuals, were performed in the physiological laboratory of Messrs. Parke, Davis & Co., in the presence of the writer, and have been eminently satisfactory from a scientific standpoint, especially as throughout they were governed by careful control investigation precluding coincidence or suggestion. In human beings in doses of $\frac{1}{8}$ grain, 70 per cent. of the injections were favorable, 10 per cent. indefinite, and the remaining 20 per cent. decidedly negative.

The evidence to be deduced from the foregoing is that in the salts of spermine we probably have a remedy of value, especially as an adjunct to other therapeutic measures; that it is far from being a panacea is patent. Though apparently innocuous, its physiological effects upon the nervous system are such as to indicate its use should be tempered with caution, since the profound exhilaration frequently induced cannot reasonably be continued without a corresponding reaction that must needs be for harm. It is excreted through natural channels.

It is also found that in spite of the general stability of the salt, *per se*, in solution it deteriorates with age, more particularly when glycerine is employed, apparently through oxidation. For this reason it was found necessary to make fresh solutions as required.

Since this product is not upon the market, and not likely to be, for some time to come at least, a few words regarding the mode of isolation may not be amiss.

The *phosphate of spermine* ($(C_2H_5N)_2H_3PO_4+3H_2O$) exists in the form of prisms and slender double pyramids, and may be obtained from fresh glandular secretion by adding a trifle of warm water, evaporating to dryness, then boiling with alcohol, permitting the insoluble portion to subside by standing some hours. The precipitate is now filtered off, washed, and dried at 100° F., and the residue, containing the salt, triturated and extracted with warm ammoniacal water, the crystals appearing thereafter on slow evaporation.

If the free base is desired, it is had by decomposing the *phosphate* with baryta and evaporating the liquid, which crystallizes on cooling. The aqueous solution of the base is precipitated by phosphomolybdic and phosphotungstic acids, by tannin, and by gold and platinum chlorides.

Regarding the irresponsible experiments undertaken, or purported to be undertaken, as reported in the general press, it may be remarked that the majority bear *prima facie* evidence of spuriousness and unreliability. We may also believe that more than one case of dangerous septicæmia has been developed as the result of such irresponsible experimentation, since ignorance of the correct method of preparing the glandular fluid direct, as employed by Brown-Sequard and the measures necessary to segregate effete and dangerous products, are practically self-confessed. The *secretio seminalis* under all circumstances is a fluid of extreme instability, and especially tends to rapid decomposition in the presence of blood serum; and unless obtained immediately upon the death of the animal, and rapidly prepared, filtered, and used, its employment is prone to be attended with disastrous consequences; even then it cannot be deemed positively safe unless the mode of preparation, throughout every stage, has been such as to carefully inculcate sterility and exclusion of all bacterial products. No such objection obtains to the salts, however, as, during isolation, they are submitted to the action of both boiling alcohol and boiling water—ample safeguards against septic infection.

Detroit, Michigan, Sept. 7, 1889.

THE Farmers' Alliance of Georgia is reported to have adopted the following resolutions:

"*Whereas*, We have been informed that some of our physicians have gone into a combine, or organization equivalent to a combine, that is detrimental to our interests; therefore, be it

"*Resolved*, That we publicly denounce any such organization, and also any physician who has or may hereafter attach himself to that or any other similar organization; and we will not patronize any physician who belongs to that society when we can do better."

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